NATURE AND RELIGION

CHARLES H. TYNDALL

MAY 22 1957

LIBRARY
EVANGELICAL SCHOOL
OF THEOLOGY

Gift of

Dr. Charles A. Mock

Digitized by the Internet Archive
in 2025

https://archive.org/details/naturereligion0000unse

NATURE AND RELIGION

By CHARLES H. TYNDALL, D.D., Ph.D.

NATURE AND RELIGION
A Handbook of Religious Education
Clo. $2.00

THROUGH SCIENCE TO GOD
Nature a Medium in the Revelation of Spiritual Truth Illus. Clo. $2.00

OBJECT LESSONS FOR CHILDREN
Truth Linked to Sight 7th Edn. Clo. $1.25

ELECTRICITY AND ITS SIMILITUDES
The Analogy of Phenomena, Natural and Spiritual Illus. 3rd Edn. $1.25

Nature and Religion

A Handbook of Religious Education

By
CHARLES H. TYNDALL

LIBRARY OF
United Theological Seminary
BL
240
I9631
1930
39.412

9148

The Evangelical
School of Theology

NEW YORK CHICAGO
Fleming H. Revell Company
LONDON AND EDINBURGH

Copyright, MCMXXX, by
FLEMING H. REVELL COMPANY

215
T

Printed in the United States of America

New York: 158 Fifth Avenue
Chicago: 851 Cass Street
London: 21 Paternoster Square
Edinburgh: 99 George Street

INTRODUCTION

ALL things had a beginning. Force, or energy, somewhere became manifest as matter, very attenuated. Attraction and repulsion operated. Chemical affinity bound atoms into molecules, and cohesion and gravitation drew these together, and we have worlds, and all plants and animal life.

When the beginning, and how long from then until now, no one can conceive, though many are the guesses. The important thing is to know more about the mysteries of the universe, our place in it, our relation to it, and how to utilize its forces to minister to our body, train our mind, and to develop our moral and religious faculties.

Such is the aim, in a humble way, of the work to which these words are an introduction.

The method of the author has been to select more or less familiar objects, and to dwell briefly upon the scientific facts well known concerning them, and then to call attention to some unusual and interesting discoveries which science has made regarding these most common things in nature.

Interesting and mysterious things lie all about us. And when attention is called to these, the very sight of the familiar objects will bring to mind those deeper and interesting facts, and be a reminder also of the moral lessons which they have suggested.

It seemed logical to begin with the greatest of all things, and that with which every child, and the most unlettered person, knows something about, the starry

UNITED THEOLOGICAL SEMINARY
22 1957

heavens, the knowledge of which, in these days, is not only thrilling, but appalling, and staggers the belief of the most profound thinkers.

Then we descend to earth, another familiar thing in the life of each one of us; but here again, in the molecules and atoms of which it is composed, we meet with most profound and astonishing facts concerning those things which we daily tread under our feet. He would be blind indeed who could not see in the facts thus made known, not only that which develops our mind, but also that which stirs and quickens our moral nature.

A more extensive view is presented to us in the familiar objects, the sea and the dry land, the soil and sand, snow and stones, all of which have many peculiar and astonishing secrets made known to us by science; and each one speaks its message to our intellect, sensibility and will.

Then we ascend the scale and consider some of the earliest forms of vegetable life, still among the common things with which we are surrounded, such as lichens, mushrooms, toadstools, the mistletoe; and then the method by which better fruits are developed in a higher realm of the vegetable kingdom, by budding and grafting, which wrought marvels under the hand of Burbank, and what this transferrence of a higher life to the living forms below has to teach us.

We then ascend in the realm of life a step higher, but still dwell upon that with which every one is familiar, blood, the life fluid of all animals, and here again new and mysterious things are discovered, and valuable moral lessons are taught, while the mind is being developed.

As we go a step higher in the realm of living things,

a low form of mammal life meets us in a creature which is more or less familiar to us, the bat; and here again its interesting characteristics and habits add to our knowledge, but also tend to strengthen the moral fibres of our soul.

Lastly we dwell upon two of those things which touch our lives vitally, both from without and within, the first by the harmonies which are being produced by all the objects in nature, the rhythmic vibrations, or music, in things seen and unseen, given under the title of the "Magic Picture"; and finally, telepathy, mind reading, and those mysteries which we read so much about, and are so little understood.

And thus starting with the universe, we end with ourselves, seemingly a very small part of it, but a part nevertheless which transcends the whole in importance. And each commonplace object, each fascinating fact, each mystery is but one more step which would lead up to the throne of the Eternal, our home, and to our Father in Heaven.

C. H. T.

St. Petersburg, Fla.

CONTENTS

I. THE HEAVENS ABOVE 13

Our Childhood Belief—The Revolutions of the Earth—Our Importance—The Earth—Its Two Revolutions—Archimedes—Motion Overcomes Gravitation—The Best Possible World—The Sun—Life and Energy from the Sun—The Sun as the Centre—The Planets—Are They Inhabited?—The Fixed Stars—The Milky Way—The Nebulæ—Questions for Review.

II. THE WORLDS BELOW 32

Molecules—Atoms—Smaller Worlds Still—Life Down Here—Questions for Review.

III. SOIL AND SAND 43

Formation of Soil—Life a Necessity—Dust—Gases Work Too—Sand—What Sand Is—Numbering the Sands—The Uses of Sand—Blowing Sand—Rivers of Sand—Preservation by Sand—Sand Blasts—Quicksand—The Age of Sand—If There Were No Sand—Within One Grain of Sand—The History of One Grain of Sand—Questions for Review.

IV. THE SEA 79

The Extent of the Sea—Evaporation of Sea Water—The Extent of the Sea Important—Minerals in the Sea—Currents in the Sea—The Gulf Stream—Icebergs—Ocean Tides—The Seascape—Life Zones of the Sea—Beauties of the Sea—Phosphorescence of the Sea—Struggles in the Sea—Living Lamps of the Sea—Men Shine—Coral—Coral Reefs—The Silent Deep—Life in the Deep—A Single Drop of Water—A Dizzy Dance—Resolved to Escape—Questions for Review.

V. SNOW 130

Two Kinds of Beauty—God's Thought in the Snow—Hidden Power in the Snow—Snow on the Mountains—The Beauty of God in the Snow—God's Goodness Seen in the Snow—Why Snow Is White—Snow as a Type of Purity—The Higher Lessons From Snow—Questions for Review.

VI. STONES THAT TALK 147

Stones Really Cry Out—Tongues in Trees—Everything Vibrates—An Ass Speaks—Stones Talk to Those Who Have Ears to Hear—Chalk Speaks—Other Rocks Tell Their Story—Mines of Ore Cry Out—The Hallelujah Chorus of the Trees—The Song of Colours—Starved Leaves—Atoms Record and Repeat—The Telegraphone—Light Registered in Glass—Light Carries Pictures—Our Secrets Revealed—The Record Erased—Light Turned to Darkness and Sound to Silence—Questions for Review.

VII. LICHENS 164

What, Where—Usefulness—First Farmers—Vicarious Sacrifice—Vital Force—Longevity—Food Values—"Manna"—Duplex Existence—Questions for Review.

VIII. MUSHROOMS 181

Toadstools—Vegetable Meat—Where They Grow—Spores—The Food of Fungi—Higher Plants—Like Blood—Two Worlds—Sunlight—Brief Life—Questions for Review.

IX. THE MISTLETOE 194

Legends—Botanical Name—A Parasite—A Worker—Questions for Review.

X. GRAFTING 206

All Good Trees Are Grafted Ones—The Method of Grafting—A Changed Tree—Pruning Off the Old—A New Tree and a New Life—Questions for Review.

XI. BLOOD 215

A Living Liquid—The Red Corpuscles—The Colourless Corpuscles—Vicarious Sacrifice—Blood Clots—The Mission of the Blood—Contact with the Blood Necessary—Blood is Sacred—Faith in the Blood—Blood Tells—A Better Story—Questions for Review.

XII. BATS 233

An Old Race—Strange Bodies—How They Live—Night Fliers—A Good Long Sleep—Vampires—Bad Company—Seeing With Nose, Ears, and Wings—Sensing Danger—Shielded From Harm—Questions for Review.

XIII. THE MAGIC PICTURE 245

Making Real the Inaudible and Invisible—Questions for Review.

XIV. TELEPATHY 254

Mind Reading—A Frequent Occurrence—Not Occultism—Mind Using the Body—Bible Examples—Many Illustrations—Is Telepathy Desirable?—Questions for Review.

INDEX 268

I

THE HEAVENS ABOVE

IN seeking to learn what nature has to teach us of moral values, we begin with the general and descend to the particular. We view the universe as a whole, and then consider some, of necessity but few, of its details. But these few are chosen because of interesting characteristics which they possess.

Man's conception of the extent of the universe has steadily enlarged for many centuries; perhaps ever since he has been an inhabitant of this earth. But this is particularly true of the past fifty years.

Not long since it was generally believed that the earth was the centre of creation; and that the sun, and the planets, or wanderers, and the stars all moved around this terrestrial sphere.

Our Childhood Belief

This was the belief of men in the childhood period of the race, and that was not strange, for each one of us had the same impression in our childhood days, until we were instructed differently; for did not our senses tell us that such was the case?

We saw the sun and moon rise and set, and as they passed from the east to the west, and disappeared from view, were they not moving around us?

And the bright morning and evening stars, which we were told were worlds like this, did the same, and so

did the great groups of stars, known as constellations, such as Orion the mighty hunter, with the three stars in a row forming the hunter's belt, and so also did such groups of stars as the Pleiades, "The seven sisters," which look like a Y in the heavens.

The Revolutions of the Earth

It seems contrary to what our senses told us to say that the heavenly bodies are not revolving around us, but only seem to do so, because our earth revolves on its axis from west to east, causing the apparent motion of these bodies about us.

The discovery of that fact was once a severe blow to the vanity of men, for they thought all the heavenly bodies were placed in the sky to give light to us, and to guide our mariners on dark nights.

It was also rather a disappointment to our childhood fancies, for we felt that our home was the centre of the world, and that the earth was the centre of all worlds.

All people in the childhood stage of development are quite likely to feel that the centre of the world is the place where they reside. When the Mohammedans controlled Jerusalem and the mosque of Omar, the Mohammedan guide who showed tourists about that building, would take them to a spot, and throw back a rug, and point to a small brass plate in the floor, and say, "This is the centre of the world. The five brass nails are the five ages of the world. Gabriel draws out one nail at the end of each age. When the last one is drawn, the end of the world comes. Put down money, and go up to heaven." Travelers are amused at seeing the centre of the world, but the sight of it means money to the guide.

Our Importance

The idea that our home is the centre of the world, and that our world is the centre of all creation, is no doubt due to the fact that we are inclined to feel that we are of special importance, and that God must regard us of greater consequence than He does others. That seems to be the tendency of the vain human heart.

The ancients thought that God, or the gods, especially favoured their nation, and despised, and opposed others. That notion does not seem to have wholly died out yet. There are some Americans who feel that God has particular regard for our nation, and has not much interest in China or India, or Africa. We are Anglo-Saxons, and superior, but they are inferior, and despicable. Such notions are vain and foolish.

It is very necessary that we learn that we are not the centre of everything. God has others who are fully as important as we, and while He is deeply interested in us, and seeks to help us, we must remember that we are only a very small part of His creation, and need to be humble, and not too self-centred. There are others of as great worth as are we, and we must consider them, for God does.

The Earth

The earth is a very wonderful body. It is filled with mysteries, so that men have been constantly discovering them one after another, and there seems to be no end to them. And the strange thing is, that as we discover the secret of a mystery on earth, that becomes a key which helps to unlock a secret to us in some other world. The lines of burning substances on

earth, called Fraunhofer's lines, reveal to us that the same substances are burning in the sun and stars.

The interior of the earth is a mystery. The rocky layers have been studied, and mapped out, but what is there three thousand miles down toward the centre? All manner of minerals are commingled with the rocky formations. Then the sea is filled with mysteries. The arctic and antarctic regions, at the poles of the earth, have fascinated men to learn the secrets of those regions, and many have lost their lives in their efforts to penetrate into those mysteries.

Compared with us men, the earth is an immense globe, about 25,000 miles in circumference. Let one travel around it, and he is impressed with its great size.

Its Two Revolutions

Its revolution on its axis, from west to east, at the rate of a thousand miles an hour, gives us days and nights, and its sweep around the sun, a distance of more than 500 million miles, at the rate of nearly sixty-five thousand miles an hour, or eighteen miles a second, gives us the change of seasons, and affords us different views of the heavens; and the accuracy, and regularity of its movements, are most interesting and mysterious.

A large part of our education, from infancy to old age, consists in learning about the earth.

It is interesting to learn why we, and all other objects, are not thrown off its surface, when it whirls about so fast; and why the atmosphere is not swept from the earth because of its terrific speed through space, and why it bends around in a circular form in its journey about the sun, instead of going straight on

into space; and why the earth does not fall into the fiery atmosphere of the sun, when that body is pulling on it with a force equal to four quintillion tons, which is equal to the breaking strength of the best steel cable eleven inches in diameter on every square foot of the earth's surface, and yet it does not move it a particle.

We say that gravitation holds us, and all things, down to the surface of the earth, but no one knows what gravitation is. Just now some think it is identical with electricity and light. But no one knows just what they are.

Archimedes

There is a well known saying of Archimedes, the Greek mathematician, that he could move the earth, had he a sufficiently long lever, and a fulcrum, with a place on which to rest it.

Suppose we could give him such a lever, and a fulcrum, with a place on which to rest it; and he, weighing 150 pounds, were placed on the end of it, and the fulcrum were one mile from the earth. Then the lever would have to be eighty-eight sextillion miles long, and when he got on the end of it, he would have to move through space with the speed of light, 186,300 miles a second, and to continue to travel for over a quintillion miles, which would take him 230,000 years, and at the end of that time he would have succeeded in moving the earth only one inch out of its path.

Motion Overcomes Gravitation

If we wish to know why the earth does not fall into the sun, we have but to think why a bicycle can keep upright, and continue on its course because of its motion. A spinning top stands upright, and resists

gravitation. It falls only when its motion lessens. A gyroscope, spun rapidly, will stand steadily on a wire, and not fall. It will even lift itself up, when one end is in the loop of a cord, if it is spun rapidly enough.

The terrific speed of the earth keeps it steady on its course. The centrifugal force which tends to drive the earth straight on, away from the sun, and the centripetal force which would pull it into the sun, being equally balanced, keep it in its path around the sun; and this is true of all planets, and all suns.

The Best Possible World

Evidently this is the best possible world which God could give beings like us, who live in such bodies as we do, and who have all our physical, mental and spiritual characteristics. The earth is just dense enough to suit our needs.

Suppose its density were doubled, then the weight of everything on earth would be doubled. The atmosphere would press down upon us thirty pounds on every square inch of surface. Men and animals would find it difficult to walk. Life would be a burden.

If gravitation were half what it is, the air would be too rarified to sustain life. Houses would blow over by every slight wind. Things would not remain where we placed them.

These, and ten thousand other things, teach us that God has given us the best possible world, and desires us to make the best possible uses of it, and of our advantages.

We should cultivate a spirit of thankfulness that we have been given such a wonderful world which can feed and clothe us, and educate us, and wherein we can learn the way to life eternal in the world beyond this.

The Sun

The sun around which the earth, and the other planets revolve, is an immense body. It is 1,380,000 times the size of the earth. One hundred and eleven earths could be strung along the diameter of the sun to reach across it. If the sun were a hollow sphere, worlds like this could be dropped into it at the rate of one a minute, without cessation, for two years, seven months, and fifteen days before it would be filled up.

The moon is 240,000 miles from the earth. If the sun were hollow, the earth and the moon could be placed inside of it, at the same distance from each other that they are now, and the moon could continue to revolve around the earth, and still be four hundred thousand miles from the shell of the sun.

If we on the earth were placed in the hollow sphere of the sun, into the shell of which were perforations through which light could enter, those lights would seem as far away from us as the stars do now.

The sun is a great fiery orb, which shoots out its tongues of flame, often four hundred thousand miles from its surface, or nearly twice as far as it is to the moon. And its fiery atmosphere is ten thousand miles deep.

Life and Energy from the Sun

All the life and energy of the earth find their source in the sun. If the sun should suddenly cease to exist, the earth would experience a cold almost like absolute zero, like that of empty space, nearly 273 degrees below zero F., and all vegetable and animal life would speedily perish.

All our trees and vegetables, and coal, are simply

stored up sunlight. All our rains are due to the lifting power of the sun in causing water to evaporate.

The extreme brilliancy of the sun hides its mysteries from us. It is difficult to learn its real nature, the source of its energy, whether or not it is cooling off, and numerous other things. Nevertheless man has learned many things concerning it.

It is about ninety-three million miles from us. The greatest speed of anything known is that of light, which is 186,300 miles a second. It would travel seven and one half times around the earth in a second. It would go around the earth 3,700 times in the time which it takes to reach us from the sun.

The Sun as the Centre

The sun being the centre of the solar system, and holding all the planets steady in their courses around it, and the source of all life, and the light of the earth, is a wonderful symbol of our Creator, who has come to us in the "sun of righteousness with healing in his wings," or rays. The sun is the great healer of our diseases, as we are learning more and more.

Like the sun which He created, He is a mystery. The very brilliancy of His being and character blinds our reason. He is the centre of all life, and healing.

"In Him we live, and move and have our being." The breath we breathe is given us by Him. He is the source of our light. He is the only one who can illuminate our darkened spirit.

As the sun draws the earth, and holds it steady on its way in the heavens, so He draws us all to Himself. "I, if I be lifted up will draw all men unto me." As the sun shines for all, and heals all, so does Christ.

But we can abuse the sunlight, so use it that it blinds

us. By refusing His light, and love, we blind ourselves, and turn that into injury which God intended should bless and save us.

The Planets

With the sun as the hub of a wheel, there are eight major planets running out, as it were, on the spokes of the wheel, until Neptune is reached, which lies on the rim of the wheel.

Those which are nearest to the sun move most rapidly in their orbits. As we have already stated the speeds of a body determine its stability in its course, the faster it travels the greater its resistance to any attraction which would pull it to one side.

The gravitative attraction of the sun on a body is inversely as the square of the distance of that body from the sun. For instance, one which is only half as far away as another, will be attracted by four times as much force as the other; one which is three times as far away will have only one-ninth of the pull on it as the nearer one. The nearer a planet is to the sun, the faster it must travel to keep from being drawn into the sun.

Mercury is thirty-six million miles out on our imaginary spoke, and revolves about the sun in eighty-seven days, going at the rate of thirty miles a second.

Venus is sixty-seven million miles away from the sun, and revolves about the sun in 224 days, moving at the rate of twenty miles a second.

The earth is ninety-three million miles away, and revolves in its orbit in 365 days, at eighteen miles a second.

Mars is 141 million miles, and its year is 687 days, and it travels at the rate of fourteen miles a second.

Jupiter is 483 million miles distant, and its year is twelve of ours, and it travels at eight miles a second.

Saturn is 886 million miles, and requires twenty-nine years to go round its orbit, at the rate of six miles a second.

Uranus is 1,782 million miles away, and its year is eighty-four of ours, and it travels at the rate of four miles a second.

Neptune, away out on the rim of the wheel, is 2,800 million miles distant, and requires 165 years to complete her circuit about the sun, traveling at the rate of three miles a second.

Mercury is the smallest of the major planets, being 3,200 miles in diameter. Its bulk is only one-fifteenth of that of the earth. The gravitative force at its surface is only two-fifths of ours, and hence one who could lift 200 pounds here would be able to lift 500 pounds there.

Venus is nearly the size of the earth, being 7,800 miles in diameter. It is nearer to us than any of the planets, twenty-seven million miles away, but it is so dazzlingly bright that it is impossible to know much about it. Like Mercury, being between us and the sun, it passes through all the phases of the moon.

The largest of the planets is Jupiter, which is 87,000 miles in diameter. This is the brightest of all the planets to us, save one, Venus, and yet to those who may live on Jupiter, we are altogether invisible. Jupiter would make 1,300 earths.

Neptune is so far away that it is invisible to us except through a telescope. If one could travel by an express train without any stops at the rate of forty miles an hour, he could go around the earth nearly fourteen times in a year. If one had started in such

a train on the day on which Adam was created, according to Ussher's chronology, 6,000 years ago, he would be traveling yet, and would need to continue his journey 2,000 years longer; for the whole trip would take him 8,000 years to reach Neptune.

These eight planets, and over eight hundred small ones, called asteroids, which lie generally between Mars and Jupiter, are our near neighbours, and are subject to the influences of the sun, as are we.

Some of the planets have several satellites, smaller attendant bodies circling around a larger one. The moon is ours. It is a small dead world, having the same face always turned toward us, so that we do not know how the other side looks. Her surface is thoroughly mapped out. It is remarkable for its valleys, mountains and plains. There seems to be no atmosphere on it. There are extinct volcanoes with craters 125 miles in diameter. These are easily seen through a fair sized telescope. Mount Newton is 24,000 feet high; in proportion to the size of the earth that would be equivalent to fifteen miles high. On the side toward us, there are twenty-eight mountains 17,000 feet high.

Are They Inhabited?

If the planets, or any of them, are inhabited, the living creatures there cannot possess the same physical powers as we. Conditions there would not be suitable for our mode of living. But that is no reason for believing that no inhabitants can dwell on them. It would not be at all difficult for God to create beings, perhaps vastly superior to us, who would readily adapt themselves to conditions which would be adverse to us. He adapts His creatures to all kinds of conditions

here on earth. Some live in the sea, and cannot live on the land. Others burrow in the earth. Some see at night better than in the daylight. Some thrive in the cold, and some in the warm climates. We live at the bottom of a sea of air two hundred or so miles deep. Put us at the surface of that air-sea, and we would die instantly. God could as readily form creatures who could live on Mars or Jupiter or Saturn, as on the earth, or in the sea or in the air. The greater the hindrances to physical life as we know it, the greater the endowments to combat, and rise superior to those hindrances, and hence the beings on such worlds as those in our Solar System, and on the worlds in the millions of other systems, would be proportionately greater than we, as they live under conditions which would be impossible for anything to live on earth.

We are certain that they are as dependent upon God for life and peace, as truly as are we. Let us hope that none of them have sinned, as have we, and brought sorrow, and death thereby upon themselves. We do not wish them to know the sorrow and tears and death which have visited the earth.

But we have promise of a world where there will be no death, and where all tears will be wiped away. Let us seek to dry others' tears, and to cause no one to weep.

The Fixed Stars

The planets are wanderers, as their name implies, for they are always changing their relative positions, as they revolve in their orbits at different speeds.

Not so the stars. They retain always their relative position in reference to one another, and so they are called fixed stars. They are not fixed in the sense

that they are stationary, for they all move, and at great speed. Relative to one another they are apparently fixed.

They are not worlds, but suns, and they are all vastly farther away than is even our Neptune. They seem like mere points of light, or less, because they are so far distant, and yet they are vastly greater than our sun, and all the planets combined, as we shall see.

The nearest of all the stars to us is Alpha Centauri, seen in the southern celestial hemisphere, which is 4.3 light years away. The brightest of all the stars Sirius, toward which the three stars in the belt of Orion point, is 8.7 light years away. Sigel, the lower right corner star in Orion, is 466 light years away, and is 4,000 times as brilliant as our sun.

When we say that it is 466 light years away, we mean that it requires the light that number of years to reach the earth, and yet light travels at the enormous rate of 186,300 miles a second, and comes to us from the sun in eight and one-half minutes. We can realize better the distance of that sun from us when we say that the light from it, which enters our eye to-night, started on its journey toward us when Christopher Columbus was a boy ten years old, and has just arrived at its destination. But compared with most others in the heavens, that sun is a near neighbour to us.

The Milky Way

The Galaxy, or Milky Way, is a great belt of faint stars which passes through the heavens. It is visible on every dark night. It is believed to be flattish in shape, much the shape of a watch case with the edge turned toward us, and its diameter is several times its thickness.

Astronomers now think that it rotates, requiring at least a hundred million years for one revolution. It forms a great spiral, and our little sun, which is really so immense, when compared with the earth and the other planets, is not far from the centre of the Galaxy, which is 55,000 light years thick, and Seares, after special study, concludes that "the diameter of the Milky Way certainly exceeds 100,000 light years, and may well be ten times that."

There are three or more trillion stars in the Galaxy, and they are so far distant, that the light blends, and forms a hazy glow, which in a good telescope, is resolved into separate suns.

This is really our universe, the one of which we are a part, and there are indications that the dark obscuring nebulæ, seen in different parts of it, are separate systems of planets, receiving their light from the trillions of suns in the Galaxy, and about which they revolve, as we do about our sun.

The Nebulæ

Lying outside, and beyond the Milky Way, are spiral forms known as Nebulæ, so called because they were thought to be composed largely of gaseous matter, which was whirling about, and gradually condensing into a sun.

Only a few years ago 7,000 of these had been mapped out, but, with greater telescopes, and using the photographic method, which can register the light hour after hour, and can be repeated on subsequent nights, as if one continuous exposure, four million such spirals have been discovered.

The brightest of all these nebulæ is the one in the constellation of Andromeda, or the "chained maiden,"

in the northern part of the heavens, and at one hour of the night is almost directly overhead in the zenith.

On favourable nights this nebula can be seen with the naked eye, and sometimes it has been mistaken for a comet.

It has been the cause of great controversy, as to whether or not it was of a gaseous nature, star-dust, in a whirl, forming a sun, or was composed of separate suns, so far distant that the light blends forming a haze.

This has been finally and definitely settled by the photographs taken of it by Major Hubble, by means of the one hundred inch telescope at Mount Willson observatory.

It was proven to be composed of separate suns, at least a billion of them, and that the group is a million or more light years away from us.

It is the most brilliant object man has ever beheld, and shines a billion times brighter than our sun. In fact, if our sun were out there, it would need to be a billion times brighter than it is, in order to be detected by any telescope in existence, or on the photographic plate.

It is known as the Island Universe of Andromeda. It is like an island in the ocean, off an immense distance from the main land, which is formed by our Galaxy, or Milky Way, the greatest of all the groups discovered.

To reach that nebula, if we could travel by airplane, or rather by an ether plane, at the rate of 250 miles an hour without stopping, it would take us two billion, seven hundred million years, and the fare at one cent for each hundred miles, would cost us six hundred trillion dollars. And to reach those spiral nebulæ, other Island Universes, which are one thousand

million light years away, would take us two quadrillion, seven hundred trillion years, and the fare at one cent per hundred miles would be six hundred quadrillion dollars.

Over four million of the spiral nebulæ, or Island Universes, have been discovered, and they lie far outside of our universe, and some of them are a thousand million, or more, light years away, and all of them are composed of millions of suns.

And all that we can know about them, or ever shall know, while we live our present life on earth, is what they were many millions of years ago, from the light of that time just arriving on this tiny speck in God's creation.

This earth of ours, as great and wonderful as it is, when compared with the suns in the heavens, each possibly having planets, and satellites revolving around it, is no more than a single tiny grain of sand among the sextillion grains of sand on earth.

In the past fifty years, man's knowledge of God's creation has grown enormously. Then, the suns at most, were numbered by the millions, and now by the hundred trillions.

To the thoughtful man, God is a greater God than He was even fifty years ago. What will man discover Him to be one hundred years hence, or a thousand years, or in the endless ages of the future?

There seems to be no end to His creation. He presides out among the farthest nebulæ, as He does here, and because of what He is, not one fails. Each one performs its revolutions, gives out its light to the possible planets which circle about it, and sings as it goes on the mission on which God sent it forth.

There are no limits to our Father's being, wisdom,

power and love. There is no such thing as time, as distance, or space to Him. He is now here every instant, in every part of His creation, and all time is an ever present now to Him.

He is fully able to take care of us, and of all our little concerns. "What is man that Thou art mindful of him?" "The heavens declare the glory of God." Will He notice us, who live on this speck of dust? Let us remember that as there is nothing great to Him, so there is nothing small. We are His offspring. He is our Father in heaven, and as a perfect Father, He loves and cares for His children.

Questions for Review

1. What were man's former conceptions of the earth as a centre?
2. What was our childhood belief of the same, and why?
3. Why did these views appeal to human vanity?
4. How have men shown a belief in their special importance, as above others?
5. What is the size of the earth? What about its secrets being revealed?
6. What are the revolutions of the earth, and its speed? Why do not objects fly off the earth because of its revolution on its axis?
7. What was Archimedes' famous saying? What would he have had to do to fulfil such a promise?
8. What simple object illustrates the overcoming of gravitation?
9. Why is this the best possible world for us?
10. What is the size of the sun?
11. Compare its size with the earth, and that of the moon.
12. What is the nature of the sun?

13. Mention some of the ways in which we are dependent on the sun.

14. How far is it away from us?

15. How long does it take the light to reach us from that body? What is the speed of light?

16. What lessons do we learn from the benefits which we receive from the sun, and from its being the centre of our solar system?

17. What are the planets? What is the law of attraction?

18. To what is their location in the solar system compared?

19. How many planets are there? Name them, and give their distances from the sun, and the length of their years.

20. Give an illustration of traveling to Neptune.

21. What are the numerous smaller planets called?

22. Tell something about the satellites.

23. Are the planets inhabited? If so, are the beings like us?

24. What about the differences of adaptation to environment of creatures on earth?

25. If the planets are inhabited, what about their dependence upon God?

26. How do the stars differ from the planets?

27. Which is the nearest fixed star? What is its distance from us?

28. Give an illustration of the time it takes the light to reach us from Sigel of Orion.

29. What is the Milky Way? How many suns is it believed to contain?

30. What is the estimated size of this band of suns? What is its time of revolution?

31. What are the nebulæ?

32. What one is the brightest? Give its size, the number of its suns, and distance.

33. At the present time, how many other nebulæ have been discovered?

34. How far away are some of them estimated to be?

35. What are these groups termed?

36. How does our world compare in size among these other worlds?

37. How does such knowledge change our conceptions of the Creator? What about His limits? Is there anything small to Him?

II

THE WORLDS BELOW

WE have looked into the heavens, and considered suns far beyond which any telescope can reach, and now we wish to look in the opposite direction, millions of times beyond the range of the best microscope, and consider the suns and worlds circling there.

Just as our conceptions of God's creation in the heavens have greatly enlarged, in fact have been enlarging for centuries, so our conceptions of what matter is composed have also greatly enlarged, particularly in the past thirty years.

Molecules

For a long time scientists have been agreed that all material things are composed of molecules. There is a general concurrence that they are "the smallest particles of a substance which can exist in a separate state, and which have the same composition as any larger mass of the same substance. If we separate the atoms of which a molecule is composed, we no longer have the substance, but its component parts, which are atoms.

"For example, if we separate the molecules of water into its component parts, we have two atoms of hydrogen, and one atom of oxygen." This means that an atom of oxygen had seized two atoms of hydrogen, and when they had combined, water was the result.

"Molecules being a combination of two or more

atoms, they are consequently larger than the atoms; and yet they are exceedingly small."

As an illustration of this fact, Dr. Willis R. Whitney says, that if a single drop of water had all its molecules enlarged until they were as large as drops of rain water, they would make enough water to cover the whole earth a foot deep.[1]

Lord Kelvin said that if a single drop of water were enlarged until it became as large as the earth, 8,000 miles in diameter, then the molecules, enlarged in the same proportion, would be larger than shot, but smaller than a cricket ball, about the size of peas. If the earth were a hollow globe, how many peas could you drop into it, in order to completely fill it?

Professor Compton says that if we could colour green the molecules in a thimble of water, and then pour the water out on the earth, and wait for thousands of years, until that thimble full of water found its way back to the ocean, and were evaporated, and fell as rain, then any drop of water the world over which we might examine, we would find to contain one of the green molecules.

"Molecules never rest. They dart about amongst one another with extraordinary rapidity. As the temperature is increased, their speed is increased also. At absolute zero their movements would cease altogether."

In a cubic millimetre of air, less than four-hundredths of an inch, at ordinary temperature and pressure, it has been calculated by Dr. Johnstone Stoney, that there are the following:

Nitrogen, thirty-one quadrillion molecules; Oxygen, eight quadrillion molecules; Carbon dioxide, sixteen

[1] "Through Science to God," p. 208.

trillion molecules; Argon, 400 trillion molecules; Neon, 400 billion molecules; Helium from twenty to forty billions of molecules, and a small number of Krypton, Xeon and Hydrogen molecules; about forty quadrillion molecules altogether, in a space about one-half the size of a pin head.

"Imagine all these enormous swarms of little missiles dashing about in every conceivable direction, each of the missiles successively encountering, and grappling with about 6,000 million of its neighbours every second, darting along the free path between these encounters with various speeds, but speeds that are so high that they average more than a thousand miles an hour. The average duration of their vibration is about the six thousand millionth of a second.

"Think then, what we take into our lungs each minute. We breathe on the average once every four seconds; every four seconds we take into the lungs one hundred cubic inches of air, or about 2,540 cubic millimetres. If that be multiplied by the forty quadrillions, the molecules in a cubic millimetre, we shall be seen to have ten quintillion of those energetic bodies drawn into our lungs with each inhalation. And each one of these is a tiny universe of itself, and moving at the speed equal to, or faster than that of our earth.

"If an ordinary electric light bulb, devoid of air, were pierced with an aperture such that one million molecules of air entered per second, the pressure in the bulb would not rise to that of the air outside for a hundred million years."[1]

How the wisdom and power of the Creator are manifested that He should cause atoms to possess what we call chemical affinity, an attraction which certain atoms

[1] "Through Science to God," p. 210.

have for others, causing them to form all the wonderful and useful combinations which we see in the world. It is by similar attractions and repulsions that we are developed in body, mind and spirit. Happy are we if we are attracted toward the good, and repel the evil.

The fascination of exceedingly unlike atoms for one another, results in the formation of something which is entirely different from either, or any of the atoms so combined.

Hydrogen and oxygen are unlike gases, and their union forms water, which is a liquid differing from both. Through the ability to choose, and the force of attraction which persons and things may exert upon us, God has willed that our lives should be formed, and our eternity determined.

All the new things which we do, or become, are the result of what is attractive to us, and of our choice. We must choose, whenever anything attracts us. What we are, and what we shall be, depends on our choices.

We may know pretty accurately what kind of a person we are, by what is attractive to us. We may also know what we shall be in the future, by what we choose now. God seems ever to say to us, " Choose you now what you wish to be hereafter."

Atoms

As we have seen, the molecules are the buildings, while the brick and mortar are the atoms. The atom is the smallest part of an element, which can exist in a molecule. Elements have only one kind of atom. There are ninety-two different atoms. Out of these all material things have been constructed. No two of these atoms are alike, and yet fundamentally they are decidedly similar, in that each one, and all of them,

consist of only three types of electrons, and these three are without doubt identical in essence, but manifest themselves in different ways. They are Protons, Photons and Electrons, or negative electricity. Whether or not we term them vortices of the ether, as Lord Kelvin did; or say that they are the basic quantums of energy, positive and negative electricity and light respectively, nevertheless, at heart they are one and the same, even though they manifest themselves very differently. They are one in essence.

Molecules are small, but the atoms are immensely smaller; two hundred millions could lie side by side in an inch space. But that does not enable us to understand how small they are.

If we had a microscope which would enable us to see things a million times smaller than we now see, we would not be able to see an atom. An illustration will aid us in understanding how small the atoms are.

As we walk along the seashore, and see the sandy beach, perhaps a quarter of a mile wide in some places, and pick up a handful of the fine sand, and then try to conceive what it would mean to count the sands, we feel that truly they are innumerable.

But, as we have shown in the story of sand, by calculation, we have learned that a million miles of shore, 500 feet wide and four feet deep, contain six sextillion grains of sand. And to count that number, it would require all the people on earth, say 1,800 millions, counting one a second without stopping, 105,626 years.

But suppose we wish to include all the sand on earth, and should estimate that it extends ten million miles, and is 1,000 feet wide, and ten feet deep. Then there would be, if all were as fine as our specimens, 333,333 in each cubic inch, and there would be all told

304 sextillion, 127 quintillion, 695 quadrillion, 872 trillion grains of sand, and to count that number it would take all the people on earth five million two hundred and eighty thousand years.

But in a cubic centimetre of steel, smaller than the cube of a little finger nail, or a child's thimble, there are a septillion atoms, or three times as many as there are in the ten million miles of sand.

It would require the grains of sand on three worlds like this to equal the number of atoms in that bit of steel. If we could take the atoms out of the steel, and lay them side by side, they would extend seventy-eight billion miles; that is twenty-four times the distance to Neptune, or twelve round trips to that most distant planet.

Smaller Worlds Still

In each one of those atoms of steel, there are twenty-six central particles as a nucleus, the protons, twenty-six electrons, negative electric particles revolving around the positive central nucleus, as so many planets around their suns, and twenty-six photons, formerly called neutrals, but now photons, energizing them all, or light-originating entities, which Professor Compton says are the life of the atom, and which give us light and warmth, and cause plants to grow.

Then in the steel system, or atom, there are seventy-eight of these electronic orbs, or as many in the centimetre of steel as there are grains of sand on 234 worlds like this.

And for all the people on earth to count them, would take one billion, 235 million years.

Then think of how many atoms and electrons there must be in an entire cubic foot of steel! And there

are many more electrons in the atoms of other substances, like gold, lead, radium and uranium, than there are in iron; three times as many in gold. What must the number of atoms be in the whole world?

In each one of those atoms, the electronic planets are whirling about in their orbits at tremendous speed, and the electronic photons are darting back and forth, and straight onward, giving forth light and heat and imparting vital energy to all they touch.

According to Bohr, the electrons nearest the central suns, move most rapidly, as do the planets in our Solar System. These speed around in their orbits, six quadrillion, two hundred trillion times a second; and the photons, ejected like comets in the heavens, travel more than 180,000 miles a second, almost as fast as light.

If we could actually see the molecules dashing to and fro, and the atoms inside of them whirling about, and the still smaller electrons inside of the atoms speeding on in their orbits, and shooting with the speed of light, doing all the marvels which we know they do in electricity, and light, what a thrilling sight it would be, like walking among the suns in Andromeda.

Vast armies of them march forth to push up grade the electric engines, and trains; others to light our streets and buildings, and others to carry our messages under the ocean in electric cables, and in the air, in our wireless and radios, and others to speed with our photographs in all directions over the world, and innumerable other things, such as developing our plant life, and energizing the earth generally.

They are under our feet, whirling systems, spinning worlds, dashing comets, and they are on our right hand and left, in the air we breathe, and in the water we drink, and in the food we eat, worlds on worlds of them.

They even constitute our bodies, our flesh and blood and bones.

Every cell in us is a universe in miniature, and every blood disk, or corpuscle, is a vast system. In reality, we are like the Galaxy, or Milky Way, so vast in extent, compared with their size and numbers.

What we touch and tread upon outnumbers the trillions of suns in the heavens so greatly, that in comparison they seem like our little Solar System along side of the Milky Way, and all the Island Universes in the Nebulæ.

And when we think that all the suns of the heavens are built out of these ninety-two atoms, or systems, and their inconceivably smaller bodies, the electrons, and that all are obeying precisely the same laws, we cannot help exclaiming:

> *"One God, one law, one element,*
> *And one far off divine event*
> *To which the whole creation moves."*

God has built the entire universe out of three tiny things, and they are so similar that no one can tell how or why they differ, the proton, electron and photon.

He deals with, and cares for little things. In fact, there is nothing little to Him, as there is nothing great.

We are assured that the hairs of our head are all numbered, and that He is acquainted with all our ways. Not only we, but the smallest thing which concerns us, He is interested in, and is able, without distraction or weariness, to care for. He is never too busy to hear us; never too far away to come to our relief. Not an electron fails in its orbit. He would not have us fail in ours; for He never forgets us, or any of our interests.

Then, with reverent awe and love we should trust Him fully.

Life Down Here

There is another view which we may take of the tiny galaxies, systems, suns and planets which swing and whirl in the material particles far, far beneath us. Comparatively, they are as far from us as are those suns in the heavens which are 1,000 million light years distant.

They too are indwelt by Divine energy, or vital force, " vis vitæ Dei," as well as are we, and this planet. Here life abounds everywhere, a single drop of water being inhabited by forty or fifty thousand creatures.

Life operates on their tiny microscopic planets, or they could not keep going. Life is within and around them. They are as much self-existent as we. Every instant, God the source of all energy, must animate them, and supply them their need as He does for us. It is as much individualized with them, as it is with us.

No two have the same mission to perform, or move in precisely the same orbit. They build their structures, spend their existence, and reach their end, and enter upon another career, as well as we.

Who knows but that the atoms teem with some kind of life, as does this tiny globe, which is so great to us? No two leaves, no two grains of sand, no two suns, no two planets, no two atoms or electrons, are precisely the same, as no two of us are exactly alike. God has expressed Himself in an infinity of forms, and ways.

While their years are in fractions of a second, ours in days, Andromeda's in millions of ages, theirs are as real, and no less important than ours is to us. We

are very great to them. Their telescopes barely detect us, we are so far away from them, like numerous light years. Will they ever know us better, and understand the mystery of our greatness?

All their knowledge, like ours, is relative. Compared with one another, in their power and importance, some of them may be great, and some small, but compared with us, they seem like nothing, as we, compared with Arcturus, and the trillion other suns, and their consorts, are so small that we seem like nothing; almost too small for God to recognize us.

But then, we remember Pascal's paradox: "We are little, almost the least and weakest of things; but we know that we are little, and therein we are great." We are never so great as when we recognize and respond to God's wisdom, love and power; for then He makes us like Himself, and we shall eternally unfold in Him.

Questions for Review

1. What are molecules?
2. Of what is a molecule of water composed?
3. Illustrate the size of molecules, as given by Dr. Whitney, Lord Kelvin, and Professor Compton.
4. What is the effect of temperature on the motion of the molecules?
5. What are the numbers of molecules in a cubic millimetre of air?
6. What of their motions and speed?
7. Give an illustration of the numbers which we inhale with every breath, and of the numbers in an ordinary electric light bulb.
8. How are the wisdom and power of God shown in the affinity of atoms for one another?
9. How do our choices affect our character?
10. How do atoms differ from molecules?

11. How many different atoms are there?
12. What is the size of the atoms?
13. Illustrate their size by comparing them with grains of sand.
14. How many atoms are there in a cubic centimetre of steel?
15. Laid side by side, how far would they extend?
16. What are smaller than atoms? Name them.
17. How many electrons in an atom of steel?
18. How do the electrons correspond with the planets in our solar system?
19. What is the relation of these bodies to the electric current, and other well known phenomena?
20. What of their presence in our daily lives?
21. How do they teach the unity of nature as mentioned by Tennyson?
22. How many kinds of electrons are there, and what are they?
23. How does all this teach us that God cares for us?
24. What is the comparative distance of the electrons from us?
25. Does life operate among them? What of their years? Of those of Andromeda?
26. Relatively, what of them and of their importance?
27. What was Pascal's paradox? When are we the greatest?

III

SOIL AND SAND

IT is a charming sight to stand on a mountain, or high elevation, and look off upon the fertile valleys, hills and forests below. Farm buildings, villages and cities dot the landscape. Roads and railways run in various directions. Truly the earth is a garden.

Were it possible for us to be transported back into the geological ages a few million years, and look from the same mountain peak, the earth would present a very different aspect. The rough, rock-ribbed crust of the earth would be bare, and seared, as if it had just emerged from a furnace.

Formation of Soil

Convulsive upheavals of the rocks, sundering the strata with loud roars would be witnessed, while new cliffs and mountains were being formed. The result of such upheavals can be witnessed among the Palisades on the Hudson River, and in the Alps in Switzerland, and among mountains everywhere.

Torrential rains would be falling upon the earth, and such volumes of mist would rise in vast clouds to the sky, that the water would be seen to ascend into the atmosphere almost as fast as the rains descended. It would be like millions of funnels pouring out their steam, so that nothing could be seen but steam and falling rains.

And this constant round of falling and rising water,

racing over the earth would wear great seams into the rocks such as we may see along the Colorado River, where vast canyons have been formed.

Beside the waters racing over the earth, wearing away its crust, and carrying its minerals to lower levels, we would behold the grinding and pulverizing effects of the ice over vast regions of the mountainous districts, during the ice age, if our visit were timed in that period. We would witness the grinding and rending of great portions of the earth's crust.

Then the expansion of the rocks during the heat, and their contraction from the cold, would rend them asunder.

Water sinking into the pits and crevices of the earth and coming into contact with the intensely heated rocks, would turn into steam, and expending over 1,700 times its bulk, would cause convulsions of the earth, producing faults, earthquakes and geysers, and other destructive phenomena, which would break up and wear down the rocks, and help to form the soil.

Life a Necessity

While the basis of soil is the sand, vastly more is needed to form fertile soil.

At first mere stains on the rocks and sand would be noticed by us in our visit to those far-off ages. This discoloration is due to the microscopic spores of lichens, and other fungi, which are so small that billions of them could be put into a cubic inch. These secrete an acid which helps to dissolve the rocks. Gradually higher forms of vegetable life appear, built upon decayed vegetables, and mineral deposits.

Then animals are found by myriads in the seas, and among the vegetables on the land, and these, through

long ages, perish, and their remains add other necessary ingredients to the soil.

Dust

Dust from the volcanoes, and vast quantities falling to the earth from the meteors, or falling and shooting stars, add their quota to the formation of the soil. Many thousands, yearly, of these small heavenly bodies, the meteors, come into contact with the atmosphere of the earth in our journey around the sun, and because of their great speed, such friction is caused in the atmosphere that nearly all of them are burned up, transformed into gases, and dust, to fall to the earth. Occasionally some large ones survive the fiery ordeal, and reach the earth, a blackened mass of mineral.

Gases Work Too

The oxygen of the atmosphere has great affinity for iron, causing rust. This agency in the air did its full share in transforming the rocks into soil.

Certain minerals in the earth would tend to combine with the gases of the air, forming powerful instruments in disintegrating the rocks. Sulphur readily combines with oxygen, and along with hydrogen, they form sulphuric acid; and the salts of the earth releasing chlorine, which unites with hydrogen to form hydrochloric acid. These would be most destructive to the rocks, but constructive agencies in forming soil.

The action of the waves of the sea, and the winds, driving vast clouds of sand, and numerous other agencies, some of which we have mentioned, would combine their forces along with the vegetables and animals, to form the fertile valleys and fields which we behold from our mountain top.

But how long it took to make the earth thus habitable for man, no one but He who reckons the cycles "a thousand years as a day," can comprehend.

Since the presence of such a thing as fertile soil on the earth, upon which plants and animals are so dependent for their existence, is so largely derived from the rocks in the form of sand, it is well worth while to devote some time to the study of that most common, but extremely interesting substance.

Sand

Sand is one of the most familiar objects of our life. So long as we have only a surface knowledge of it, like many other common things, such as air, water, light, sight and hearing, it is uninteresting. But as we penetrate into its secrets, we discover it to be most wonderful, mysterious and useful.

It lines the shores of every sea, and sets bounds for its waves. They roar and dash upon it, yet cannot prevail over it.

If the seashore were lined with fertile soil, it would soon be dissolved, and washed away. If rocks bounded the sea, the waves would dash upon them, and the launching and landing of boats would be exceedingly difficult, or next to impossible.

Sand is most yielding, and flexible, and yet is exceedingly impenetrable and rigid. Bags of it are used for defence in fortifications, and projectiles shot into it penetrate it but a short distance. It cannot be shivered into dangerous fragments, as are rocks and other solid substances. Waves dash it to one side, but it quickly settles back into its former bed.

Particles of gold, and other valuable minerals are not infrequently found in the sand, and miners follow

up creeks, and work along rivers, sifting out these treasures hidden in the sand.

But there are treasures hidden in it which defy the sieve, and are discovered, and recovered for man's uses, only by the most searching, and powerful, chemical and electrical, mental and spiritual forces at our command.

It is well worth our while to work this rich mine, over which we have walked all our life, and which abounds on every hand. It is very well known to us, and yet is replete with mysteries, which we may come to understand by patient investigation.

A child can toss handfuls of it into the air, and with shovel and pail, toy with it on the shore, and the winds can sweep it along whither they will, and yet it can be to us a most dangerous foe, or an exceedingly beneficent friend.

What Sand Is

Sand consists of particles, more or less fine, of disintegrated rocks. These are broken, and shivered into fragments by the internal forces of the earth, by cold and heat in their contracting and expanding powers; by the dissolving action of waters; by the rasping forces which play upon the rock fragments as they are swept along in river beds, or are dashed against one another by the waves on the shores of bodies of water; by the glaciers as they slowly grind their way through ravines down mountain ranges; by the disintegrating tendency of the acid secreting roots of all vegetables, from the lowest lichen to the tallest giant of the forest; by the action of the gases of the atmosphere, and by innumerable other and secret forces, altogether forming a partnership, and coöperating with those mentioned above, in the most intricate, hidden and widest ramifi-

cation conceivable, to reduce to tiny grains the rocky crust of the earth.

Nearly all pure sand consists of quartz, which is a very abundant mineral, and is made up of silica. Quartz is simply the crystalline form of silica, a constituent of granite, and abounds in rocks of all ages, and makes most of the sand by the seashore. Silica and silicon oxide constitute ordinary quartz, or sand. It is formed from silicon, and next to oxygen, is the most abundant element of the earth's crust.

Infusorial earth, which occurs in extensive beds, is made up chiefly of microscopic silicious shells. How this has come about is an interesting process.

Silica, in the form of hydrates, enters more or less into solution in all river waters as the waters tend to dissolve out the minerals of the rocks over which they flow. These river waters containing the silica are carried to the sea. There minute living animals, the Infusoria, and others, use up the silica for their bodies, and at their death, the skeletons fall in vast numbers to the bottom of the ocean, which becomes covered with silica brought down by the rivers from the land. And thus, life processes keep the waters of the sea from having too great a quantity in solution. And so there is a wonderful coördination between the land and waters, to constitute that state of equilibrium which is requisite for the life, maintenance and health of all living creatures. Sand has its part in this beneficent task.

A large part of the earth's surface is covered with sand. It is an important constituent of all soils, and occurs in abundance in arid regions, on the shores of the seas, along the courses of rivers. Vast regions of the earth, which in earlier geological ages were covered

with water, are really the extensive shores of those ancient seas, and rivers.

Numbering the Sands

As to the number of the grains of sand, the Scriptures speak of those by the seashore as innumerable, and liken the racial and spiritual descendents of Abraham, as the result of divine favour and blessing, to such an unnumbered host.

While no one could count the number of the sands lining the shores of the sea, though he might live to the age of many Methuselahs, still we may make a fair estimate of the number.

By carefully counting out, under a microscope, one thousand of the finest grains secured from the coast of Florida, and placing them in a finely graduated container, we found that three cubic inches of sand number 1,000,000, and that one cubic inch contains 333,333 grains.

If we estimate the number of miles of seashore on earth as 1,000,000, and that they average 500 feet wide, and four feet deep, then in one mile of that width and depth, there are eighteen billion cubic inches of sand, or six quadrillion grains of sand. In the one million of miles of such shores on earth there are, accordingly, six sextillion grains of sand.

If we wish to gain some slight idea of the number of the grains of sand over the whole earth, we might extend the miles to ten millions, ten feet deep, and an average width of one thousand feet. That number of miles of sand, according to our estimate as to the number of grains in each cubic inch, if all were as fine as those counted, would contain twenty-five and one-third sextillion grains, and to count them, all the per-

sons living on the earth, say two billions, counting at one a second, ten hours a day, and 365 days in the year, would have to count for more than 962,463 years.

Sand has long been used as a measurer of time. As the sands fell in the hour glass, which was used to mark the passing moments, men came to speak of the " sands of time," to indicate the constant and rapid passing of time. In the olden days, before we had our modern timepieces, clocks, and watches, public speakers, and others, who needed to take note of the passing of time, kept their eye on the falling sands in the hour glass, and as soon as the sands in the upper part of the hour glass had run out, the glass was reversed, and the process was repeated.

Of course, no such turning back of the hour glass of our life is possible. There used to be a hymn sung, which ran:

" Time speeds away, away,
Another hour, another day
Another month, another year,
Drop round us like the lifeless sear."

The sands being innumerable, are used to give us an idea of the countless mercies of God, long ago promised to Abraham, and through him to his offspring, and to all who by faith become his spiritual descendents, and heirs of those promises which have been filled full by Christ. Now all men share in those Divine favours, and we can no more count them, though all the world should join in doing it, than we can count the sands. And still those mercies continue, in increasing numbers to fall upon us, and upon all men, from the loving and beneficent hand of the heavenly Father. And so, through the ceaseless ages His loving kindness and

tender mercies will go on increasing, gaining on the ability of us men to count them, until with hearts overflowing with gratitude, we shall be compelled to exclaim: "How manifold are Thy mercies, O Lord!" And even now, with our slight realization of His goodness we can sing:

"How strong and sweet my Father's care,
That round about me like the air
Is with me always everywhere;
He cares for me."

The Uses of Sand

The importance, and uses of sand, are vastly greater than we usually realize. We are all familiar with its use in making mortar in building operations. Cement, or lime, when used alone has little adhesive power, and so some kind of hard material in particles, or granules, facilitates the setting of the mortar, and renders it harder and more adhesive than when cement is used alone. The harder and sharper these particles are the better, as the brick and stone have always some irregularities, or pits, on the surface into which these angles, or sharp points can enter, and form what is called a key. Clean sharp sand, which is free from loam or soil is best. Crushed quartz, being so sharp, is the most desirable kind.

Sand is an important essential in the manufacture of glass. Pure quartz, crushed sandstone, pulverized flints, especially sand of degrees of varying purity in proportion to the quality of glass to be made, along with lime in the form of chalk, or marble, and potash and soda, are fused into a molten mass, and when rolled and moulded, tempered and cooled, form our glass in

every conceivable variety. Iron-free sand is especially sought for in the manufacture of glass.

Sandstones have always been useful in building construction, and for numerous other purposes. Sandstone rock is formed of consolidated sand. The component grains are for the most part quartz, a most durable mineral which must be regarded as the residue left after all the more decomposable minerals of the original rocks have been carried away in solution, or suspension, as fine mud.

The colours of sandstone arise, not so much from that of the quartz, which is commonly white or grey, as from the film or crust which often coats the grains, holding them together as a cement. Iron is the greatest colouring ingredient of rocks, and in sandstone it gives rise to red, brown, yellow and green hues, according to its degree of oxidation and hydration. In ordinary red sandstone each grain of sand is coated with red earthy hæmatite. In yellow sandstone the oxide has become hydrous in the form of limonite, which mineralogy defines as an earthy, silky submetallic, which is a shaded brown or yellow hydroxide.

A piece of fine grained sandstone seen under a microscope looks like a coarse conglomerate, so that the difference between the two rocks is little more than relative size.

Quartz, sandstones, and other forms of silica, contain over forty-five per cent. of their weight of the element silicon, which is more abundant than any other element, with the possible exception of oxygen.

The great mass of the rocks and soil is made up of different compounds of silica with metallic bases. And so sand in one form or another is an essential of good soils. Many soils are barren because of a lack of this

mineral, silica, which is a food for, and enters into the structure of plant life. Silica is the main material of the plant skeleton. Of the ashes of plant stems particularly, silica is generally found to be a large constituent. The ashes of rye straw is formed of 65%, potato stems 36%, and of wheat straw as much as 73%. Hence the importance of the existence in soils for growing this class of plants of silica, in such a form as it may pass in solution into their roots.

Sand is used in horticulture to lay around choice bulbs, at planting time, to prevent contact with the earth which is, perhaps, manure tainted. It is needed in potted plants in order to give the earth porosity to carry off all excess moisture from the roots.

Extreme fluctuations of climate are found most where there are large tracts of sand, because these are influenced by the changes of temperature, and of the moisture of the air. While, on the other hand, extensive forests tend by their shade, to mitigate the extremes of temperature, and to distribute its daily changes more equably over the twenty-four hours.

An interesting use of sand is made in the launching of ships, particularly large steel battleships. Beneath the saddle on which the ships rest, are placed bags of sand. When the props which hold up the ship are removed, it settles gently upon the bags of sand, and the bags burst under the great weight of the ship, and the sand runs out, and slowly the great hull of the ship settles down upon the greased slides, having had no jar or strain whatever. Then the jacks are applied to the bow, and it is easily and smoothly sent down the slippery incline into the water.

Sand performs an important mission in its being able to remove dissolved matter from water. Water

which contains 1.42 grams of salt, sodium chloride, per gallon (70,000 grains), was deprived of 22% of the chloride of sodium by filtration through a depth of one foot of sand. The sand did not dissolve the organic matter, as charcoal would have done. This filtrating property of sand is most important as it lies mixed with, or is beneath, the soil. It tends to retain the poisons which pass through it in solution, and so to protect man from diseases, contagious and otherwise, as he uses the water which has fallen as rain, and percolates through the soil.

Blowing Sand

Sand being composed of grains, more or less small, is capable of being easily shifted. Blown sand is sand lifted by wave action, and blown into long ridges or dunes by prevailing winds. It varies in composition, as ordinary sandstones do, being sometimes entirely silicious, and sometimes calcareous where derived from triturated shells, or other calcareous organisms.

Calcareous blown sand is compacted into hard stone by the action of rain water, which alternately dissolves a little of the lime, and redeposits it on evaporation as a thin crust, cementing the grains of sand together.

Some sandstones are one-third lime and two-thirds quartz, and occasionally crystallize into rhombohedrons. This mineral is employed in many ways. The coarser varieties, when burnt to drive off the carbonic acid, are used as lime for mortar; as manure, and for tanning; as a flux in melting iron and other ores, and in the manufacture of glass, and for other purposes. The finer varieties, as marbles for sculpture, architecture and ornamental stone work, and as chalk for writing, and whitewashing, and for producing carbonic acid gas.

The softer quartz rocks of the Quaternary and Cretaceous series, have been made to yield the sand which, drifted and sifted by the winds, has taken on the form of dunes. The slightest breeze is enough to make the surface "smoke" with sand dust, and at times it is said that the weird singing of the sands, waxing louder and louder, informs the investigating traveler that the motion "is not confined to the superficial particles."

These sand hills, or dunes, occur in numerous regions of the earth's surface. Along the shores of Lake Michigan are vast waves of shifting sand. The sand hills of Nebraska cover an area of 8,000 square miles. In Peru are great accumulations of drifting sand. This usually forms isolated hillocks, of a half moon shape, having their convex sides toward the trade winds. They are from ten to twelve feet high.

Blowing sand along seacoasts is often ruinous to farm lands, and this can be prevented in a large measure by planting the sand banks with sea-bent, and other forms of grass; the matting fibres, roots and stems of which not only bind the sand, but clothe it with vegetation which is useful as food for grazing animals. Much of such grass has to be planted, which is the better method, but the bent-grass can be propagated by the seed.

Sand is thrown out of the earth by volcanoes, along with ashes and lava, indicating that the internal commotions of the earth have pulverized the rocks into sand. The Sahara Desert is by no means a level country. It has mountains over 6,000 feet high. It is not a monotonous extent of sand. It has sand dunes which extend in an unbroken chain for 2,000 miles, with an average width of 200 miles. These constitute one-ninth or one-tenth of the Sahara Desert.

Rivers of Sand

Rivers transport large quantities of sand. It is estimated that every year the Mississippi River carries into the Gulf of Mexico 750 million cubic feet of sand, earth and gravel. This would equal a prism 268 feet high, with a base one mile square. Other rivers like the Nile, Amazon, and many more, perform the same task of conveying the disintegrating rocks, in the form of sand, onward toward the sea.

The great sand rivers which are described by Livingstone in his journeys through equatorial Africa, consist more of sand than of water. He describes the Zingesi as a sand rivulet in flood, sixty or seventy yards wide, and waist deep. Like all these rivers, it is for the most part dry; but, by digging down a few feet, the water is to be found which is percolating along the bed, on a stratum of clay. In trying to ford it, he says, " I felt thousands of coarse particles striking my legs, and the slight disturbance of our own footsteps caused deep holes to be made in the bed. The water which is almost always rapid in such rivers, dug out the sand beneath our feet in a second or two; and we were all sinking by that means so deep that we were glad to relinquish the attempt to ford it before we were halfway over. The oxen were carried away down into the Zambesi.

" This gave me the idea that the amount of sand removed by every freshet must be very great. Vast masses of disintegrating rock are thus removed by these rivers, before it is fine enough to form soil. The man who preceded me was only thigh deep, but the disturbance caused by his feet, made it waist deep for me.

"In most rivers where such wearing is going on, a person diving to the bottom, can literally hear thousands of stones knocking against one another.

"This attrition is being carried on for hundreds of miles in different rivers, and must have a greater effect in wearing away fragmentary rocks, to produce sand, than all the pestles and mortars, and mills and rock crushers in the world, were they doing nothing else but grinding and wearing away the rocks to form sand for bounds of the sea, and for soil for the service of man."

Preservation by Sand

Drifting sand is capable of preserving organic remains, and works of art. On visiting the Pyramids of Egypt, and particularly the region west of old Memphis, in the vicinity of the Steps Pyramid, one is impressed with the wonderful way in which the sands of the Libyan Desert have been blown in and covered the numerous tombs, which extend for miles along the west bank of the Nile. There the valleys open into plains, and there are gorges open through the mountains, and the sand has been drawn through these, and covered the tombs containing mural paintings, and other works of art. Some of these were uncovered by Marietta, and others. There was found the great tomb of the bulls of Apis, which had been buried and preserved by the sand. The whole soil of the Necropolis is so honeycombed with tombs covered by the sand, that caution is necessary when traveling in that region.

The same condition prevails for many miles on the west side of the Nile, from Gizeh, and the great pyramids, all along the Libyan Desert.

When a vessel is stranded in shallow water, it usu-

ally becomes the nucleus of a sand bank, just as the African sand winds raise a small hillock over the carcass of every dead camel exposed on the surface of the desert.

Lyell's Geology states that whole caravans have been overwhelmed by the Libyan sands, and whole towns have been buried thus, in England, France and Jutland.

It has been found that buildings along the seashores, where sand is blown to any considerable extent, have their window glass depolished. This is caused by the impact of the separate particles of sand, as so many projectiles striking against the glass, causing tiny pits in the surface of the glass.

In deserts, like the Sahara, the surface of the rocks, heated by the sun, and suddenly chilled by the rapid radiation over night, gets fractured and crumbled; elsewhere the cliffs have been scored, and the sand thus formed is at once turned by the wind into an active instrument of corrosion. In many places the sand has planed the surface of the rocks as smooth as ice. In other places it has scored the vertical faces of the cliffs with curious imitations of glacial striations, and tended to undercut the pillars, or table-like prominences, which under the name of gurs, or "whitenesses" are among the most familiar products of erosion in the Sahara Desert.

Sand Blasts

The injury which has been produced by blowing sand, like many other deleterious objects in nature, by the skill of man, has been turned into channels of usefulness.

It was long ago discovered that sand driven by a

blast of air could be used for all kinds of cutting and engraving. The great cutting power of sharp sand, which has played so important a part in the erosion of the rocks as carried by the wind, suggested its use in cutting, grinding, engraving, pulverizing stone, glass, metals, pottery, wood, and in fact all kinds of materials the surfaces of which were not too soft and yielding.

A stream of sand is blown against the objects by means of water, air or steam, under high pressure. A stencil is made, usually of rubber, or some yielding material, and those parts exposed to the sand blast are soon cut away, and the etching or engraving is soon accomplished. If glass is not covered it is simply frosted. This is used in foundries for cleaning castings, which are too large to be handled by tumbling.

Many years ago patents were issued for this method of cutting, boring, grinding, dressing, engraving and pulverizing of stone, metals, glass and numerous other materials.

By this method, with sand of average fineness, and a pressure of four inches, ordinary glass is depolished or frosted in ten seconds. Any substance which is pliable and tough can be used to cover those portions of the pattern which it is not desired to cut away. For instance, a fern leaf attached to a sheet of glass by gum-water, will perfectly protect the surface beneath it from erosion, while the unprotected portions are fully depolished. If the action of the blast be continued, all the softer parts of the leaf are first removed, and so the venation of the frond is accurately reproduced on the glass. A signature written upon any hard surface, with a pen dipped in liquid glue, protects the surface, so that after the action of the sand blast, the removal of the glue leaves the autograph indelibly traced in

transparent lines. Most accurate reproductions of line engravings have been transferred to glass by the method used in photography known as the collodion, or gelatin process. All kinds of ornamentation in stone, wood, glass, and other hard substances, are procured by this process. The action of the sand blast is due to the actual pulverization by impact, each grain of sand acting by its own velocity or momentum, like a bullet or projectile, pulverizing, cutting, or indenting the object which it strikes. A dull red light may be observed where the sand impinges on the stone or glass, as red particles fly from steel when struck by flint.

It might be observed, while passing, that there is a principle involved in the operation of the sand blast, which is worth practicing in our lives.

Some natures are hard-surfaced, like glass, and other unyielding substances, which are so quickly eroded by the impact of the sand beating upon them. They take their position or stand on a matter, and cannot and will not yield, no matter how much reason may be arrayed against them, or what force of circumstances may be brought to bear upon them. They are as inflexible as flint, and as unchangeable in mind and opinions, as were the laws of the Medes and Persians. The storms of life rage against them, but they will not give way. Trees stand rooted in their place, and know how to bend to the storms which bear down upon them. Their very flexibility is the source of their safety, while unyielding structures are shattered into fragments.

To know how to be strong in weakness, because of being able to yield when one ought to yield, and to resist by means of one's frailty, is a wonderful secret. A fern, because it can bend, is a greater protection against the impact of the sand projectiles, than are

steel or flint. To know how to be both fern and flint, is an invaluable secret.

In recent years, man has been taught that he accomplished most in his defense against the encroachment of insomnia, and other nervous disorders, and their devastating blasts, by relaxation, or a yielding, and utter surrender of the tension under which he is when he is in a state of resistance. Fortunate is the one who knows how to yield when he ought, as well as how to stand fast in the face of temptation.

Prior to the time when blotting paper was discovered, fine sand was used for blotting purposes. A receptacle, with small holes, stood on the writer's desk, and to absorb the surplus ink in the writing, the sand was sifted upon the paper, and was then poured off.

Sand mixed with soap is used for toilet purposes. Sharp sand with varying degrees of fineness, is spread over paper, and is used for polishing and grinding, and is known as sandpaper.

A sand tube, or fulgurite, is sand vitrified, and is supposed to have been fused by a stroke of lightning.

The secret treasures which are doubtless hidden in the sand, and will some day be revealed and extracted, can now be only faintly conjectured; the iron, gold, precious minerals, and countless valuable properties, and protective powers for human welfare, are stored there, waiting the dawn of the age when its secrets shall be disclosed.

Quicksand

It seems strange that sand is often quite impervious to water. One would think that the water would percolate through it most readily, but such is not the case.

Who has not noticed that if he had occasion to water

plants, trees, or vegetables situated in sandy soil, that as he turned the water on freely, it would cover the surface, possibly an inch deep, but did not seem to "soak in" readily. A slight movement of the water, and the sand beneath it, would reveal the fact that the water had not penetrated over half an inch or so, and only as such sandy soil is covered thoroughly with water, does it settle down into the soil, and reach the rootlets which it is sought to supply with water. If the sand be stirred, the water passes through it more readily.

Perhaps there is no soil which is more impervious to water than most sand; particularly is this true with what is termed "sharp sand," that is sand the particles of which have sharp edges, and approach more or less the shape of cubes with square corners. Such grains of sand fit into one another, and lock somewhat closely, because of the downward pressure caused by gravitation, thus leaving comparatively few openings, or holes, between the grains through which the water may pass.

If the sand were perfect cubes, they might be made to join together so snugly that a few layers of them, one on top of the other, would present a sufficiently impervious barrier to the water so that it could not pass through at all. Then, if these tiny blocks of sand were separated, stirred up, the water would readily pass between them. This is why it is that heavy rains, which beat upon sandy soil, sink into it. They stir the sand, and permit the water to penetrate it more readily.

In quicksand the particles do not fit together so closely. Such sand is generally found at the mouth of rivers, or streams, or where they have once been, which empty into larger bodies of water. The action

of the currents, and of the waves, or tides, caused by their meeting, wash the sand particles to and fro, and this constant agitation, or beating of the grains against one another, wears off their sharp edges, and finally makes them smooth, rounded bodies, which cannot pack closely together, and this leaves small holes between them, and hence any heavy body, like water, passes through them with ease, and so, too, man, or an animal, or any weighty object, easily sinks down into it, and may disappear altogether.

Quicksand in the bottom of wells, or in other parts of the earth, is sand which has gone through this same rounding and smoothing process, because of the action of water, or from other causes. And hence it is that quicksand is most difficult in which to make a foundation for a bridge, or for any other structure. It will not pack closely around the object, be it an abutment, pile, or other structure, so as to hold it firmly, as will ordinary sand, or soil.

There is one peculiarity with quicksand, which people having to do with it need to learn. In passing over it one needs to keep moving. If he stops, and stands still, he sinks into it very quickly; and vehicles driving over it must keep going for the same reason.

Bodies which are forced down into quicksand are recovered with great difficulty. They keep sinking until they pass entirely through it. And when the attempt is made to draw them up, not only the gravitative force has to be overcome, and the weight of the water surrounding it, but the upward movement tends to create a vacuum below it, and that means a downward pressure upon it of fifteen pounds per square inch of its surface. And hence, when men or animals sink into quicksand, and the effort is made to pull them out,

they are liable to be torn asunder by the operation. They must be supported, so as to remove their weight from the sand, and then the sand and water loosened up around them, before they can be safely lifted out.

Quicksands are a very apt metaphor of the experiences which are often met with in life. Sin of any kind has in it the nature of quicksand. It seems to create an environment which causes one to sink morally, and that very rapidly, when he remains in it. His only safety is to pass over it, and through it, as quickly as possible. To stop is to perish. It is so easy to go down under its influence, and so difficult to be extricated from it. It is a heart-breaking sight to witness one sinking into the quicksands of immorality. His rescue is next to an impossibility. Only the infinite Spirit of God is able to bring him up out of that "horrible pit and miry clay, and to set his feet upon a rock, and to establish his goings."

There are natures, and institutions, as well as experiences, which are like quicksand. All the valuable things, such as God's favours, the benefits of our civilization, and efforts of friends and loved ones, sink into the life and are lost. They add nothing permanent and helpful to such a nature. Gifts which ought to enrich the life are worthless.

Self-conceit is also such a quicksand. Pour whatever you will into such a life, and it sinks out of sight, and is lost.

Nearly all social life is another of the quicksands. It promises much, and gives but little, and one who becomes immersed in it, goes deeper and deeper. The next time it will be more satisfying, and so the soul is led on and on, and never finds solid contentment, and yet he is unable to extricate himself from it.

Ingratitude develops in one a quicksand nature. He receives and receives, and is none the better for it. All the favours and blessings are taken into the thankless heart, and are lost; they are worthless to the recipient.

Like the fertilizer, and top soil, put upon certain Florida sandy soil, intended to enrich it, they quickly pass through it, and then are worthless, and the same process needs constantly to be repeated.

Union with Christ imparts to one a stable nature. He is no longer like shifting sand. Such an one can sing:

> *" On Christ the solid rock I stand,*
> *All other ground is sinking sand."*

Sand, like water, tends to seek the lowest level. All fragmentary materials tend to group themselves according to size, and relative density. It reminds us of the homely adage: " Birds of a feather flock together." We are wont to fall into our own group, or kind, and to manifest a stratification, as sand is apt to occur in layers, and to show stratified characteristics of sedimentary rocks. These may enclose the remains of plants, and animals entombed on the same seashore, river bed, or lake bottom, which existed during the age in which the stratified sand-rocks were formed. It is said that Judas went to his own place, and every one will ultimately find his own place, according to his size, and the relative density of his character and deserts.

There is not more harmony of action, coördination, by the muscles of the body, than is manifest by the photons, electrons, protons, atoms, molecules and grains

of sand, as they fit into the niche in nature for which they were designed. And they perform their revolutions and operations in tune with the rhythmic forces which play over them, as truly as is done in the most sensitive radio receiving set.

As one illustration in which grains of sand marshal themselves into harmony with the rhythmic vibrations of the air, it is said that not infrequently, especially at early dawn, there is heard a musical noise in deserts, like the sound of distant drums, which is caused by the eddying of the grains of sand in the heated atmosphere, as it plays over the " mendanos," or hillocks of sand.

Sand easily conforms to wave vibrations, as is seen in the well-known Chladni figures forming symmetrical curves, or figures, which are manifest by the sand as it settles upon the nodal lines of metallic or glass plates, when the latter are made to vibrate by drawing a violin bow over the edge of the plates.

The same tendency is shown by iron filings which arrange themselves into magnetic figures, when they are brought into a magnetic field, near an electron, or any other charged magnet.

Powdered granules of red lead, and sulphur, and other powdered substances, when sprinkled upon a non-conductor, and brought near to an electrically charged body, arrange themselves into symmetrical forms, in harmony with the invisible electric lines of force playing over them. They really conform to the harmony or musical vibrations, caused by the photons, protons and electrons, which we call electricity.

Sand derives its usefulness, and is able to perform its beneficent operations because of its ability to enter into combinations. One grain alone is so insignificant as to be inconsequential. But when it is combined with

others, and coöperates with other things, it makes a very large part, if not most, of what we see, and handle, and call the material world. In our childhood days we were reminded that:

> *"Little drops of water, little grains of sand,*
> *Make the mighty ocean, and the pleasant land."*

And so we learn not to despise small things. The earth, and our universe, and all others, are made up of them, and as truly as our lives are made up of moments, hours, days and years, so our character is built up of single acts, each adding its part to the structure which we rear, good or bad, and which shall be a joy or a shame to us, even after the sun has ceased to shine, and on to infinity, world without end.

Like a single act, or one determination of the will, a grain of sand, when out of its place, may do great harm. In the eye, or in a watch, or in any other delicate machinery, it causes friction, and is ruinous.

Think of anything, or of any person, or of his single act, being out of place! Sand, or men, being where they were not intended to be, not only cease to be useful, but may cause incalculable harm.

One grain of sand, driven by the wind, flies into the eye of the driver of an automobile, and blinds him for a moment. He loses control of the car, which dashes over an embankment, and the father, mother and three children lose their lives. What those parents and the children might have accomplished, had they lived, no one can tell. A grain of sand changed the course of history.

What may not one act of a thinking, willing person

do to bless or to harm the world, and to change human destiny, only God can know.

> *"Far better in its place the lowliest bird,*
> *Should sing aright to Him the lowliest song,*
> *Than that a seraph strayed, should take His word,*
> *And sing His glory wrong."*

The Age of Sand

The generations of humanity have come and gone since man first appeared on earth, it matters not how far back you place the date; great forests have sprung up, and grown to maturity, many of the trees of which surpass in size our gigantic Sequoia; and animals have appeared on the earth, in size, from the microscopic Infusoria, to the mastodons and great whales, leviathans of the sea, but all these were antedated by the humblest sand which we tread under foot, and it will endure after all the great and imposing sights which we witness have ended their career, and have passed into oblivion.

The very durability of the sand commends it to our consideration and respect. In this it is a type of the spirit of man. The tiniest infant of the most humble mother who ever lived, is entitled to our reverent respect, because it will endure when all things on earth, and all the suns in the heavens have ceased to exist.

Notwithstanding its durability, sand is so shifting that we are warned against building upon it. Structures reared on it are lacking in stability, and are unable to endure the pressure of storms. Sand is easily washed away from a building which rests upon it. The application of this to our lives is most apparent. The unwisdom of basing our hopes on the fluctuating opinions of men; and, most of all, depending for peace and se-

curity in the ages of eternity, on the transient and vanishing things of time, is vastly more foolish than to build on the sand. Why do that, when we can so easily build on the Rock of Ages?

If There Were No Sand

It would be impossible to recount all the blessings which have come to man through the combination, action, and uses of single grains of sand. If we could know them, we would discover that man and his welfare are largely bound up with the history and uses of sand. In other words, there is such a linking together of things in creation, that if we should break the combination, calamity would instantly result.

Think what would happen if God should recall every grain of sand which exists now, or ever has existed, and should cast them all into oblivion! What a crash of human structures! Pandemonium and despair would instantly result.

Had there never been any sand, who can conceive the kind of a world we would live in, or of the kind of a being man would be? No mortar, or brick, and so no stable buildings; no seashores as now, no fertile soil, and most vegetation would not exist; no stalks of grain could grow for the sustenance of animal life; no fine glass for windows, lenses, and ten thousand other things.

What kind of a being man would be if he had never had the advantage of these things, it is impossible to conceive. He surely would not be what he is now, if he would be in existence at all.

If by a single omnipotent act all sand everywhere were called out of its place, and out of the many transformations into which it has been fitted, there would

be such a crash of nature, and such a destruction of the necessities of life, that none of us could long exist, and soon all animal life would become extinct. This would become a dead, barren world.

This is true also of numerous of our common blessings. We cannot realize their importance until we consider how calamitous it would be, if they were taken from us.

Within One Grain of Sand

In the tiniest grain of sand there are molecules, atoms, electrons and protons, and doubtless photons, all in a state of vibration and revolution, which keep as exact time in their motions, as the sun and stars in the heavens.

The energy locked within that bit of matter is incomprehensible to the human mind. Slight glimpses are caught as it is manifest in the disintegration of the Radium atom.

The light given off by the process, caused by the impact of the gamma rays, and known as photons, will penetrate over seventy centimetres of water, or rather more than 27.5 inches; but according to Millikan, the cosmic rays which he discovered, are a hundred times more rapid, and a hundred times more penetrating, and will pass through 225 feet of water, or eighteen feet of lead.

These rays, far beyond the range of human vision, he believes are caused by the energy manifest in the formation of matter, or a winding-up process. The photons may have their part in the production of this transcendently penetrating light.

Twenty-eight hydrogen atoms unite to form one atom of silicon, which is the base of silex, or sand.

The twenty-eight electrons, twenty-eight protons, and a similar number of photons, hold one another in a state of equilibrium, by their attraction, and rapid revolutions, 200 trillion revolutions a second, and 180 thousand miles a second. The protons are the central suns, along with the photons; and the electrons are the planets revolving around them. They are positive and negative electricity, the materials, aided by the photons, out of which all things are made.

Their centripetal, or attractive force, and the centrifugal, or repellent forces, are so nicely balanced, that a state of equilibrium is maintained, as is the case with the sun and earth, and all other heavenly bodies.

To create one gram of pure electricity, electrons, would require one trillion horse-power of energy, working 680,000 years; and according to E. F. D'Albe: "If two grams of pure electricity, or electrons, were put one centimetre apart, they would repel each other with a force equal to 320 septillion tons," which is 100,000,000 times the gravitative pull of the sun on the earth, four quintillion tons. That is a force which, all other forces being nullified, would lift, pull or push aside 100,000,000 worlds such as this.[1]

These electrons, photons and protons are locked within the molecules of grains of sand, but their forces are so nicely balanced, that they are inert, and we can toss them to and fro, and the winds can sport with them.

There is no limit, humanly speaking, to the power within them, because God is behind them. The same Mind and Power are within them, which are within, and control, the countless billions of suns in the heavens. They obey the same laws.

[1] "Through Science to God," by the Author, p. 183.

We stand between two universes, the infinitely great, and the infinitely small. By the telescope we learn of the four or more millions of the spiral nebulæ, or Island Universes, which lie outside of our Galaxy, or Milky Way, with its belt of faint suns numbered in the trillions. Those distant universes are so far away that it takes the light, which travels 186,300 miles a second, from a million to several hundred million years to come to this earth.

And we turn our wondering gaze into the opposite direction, and look through the microscope, and go vastly beyond its range, into the region of the infinitely minute, by means of chemical and electrical processes, thirty-seven billion times beyond the region manifest by the best spectroscopes, far down among the things, the reflection of which we behold in the ultra microscope, and there twinkling like stars, and like stars too in that their actual shapes are not delineated, though we see the light which they flash back to us by means of the minute, but intense ray, which, through a tiny window, was thrown upon them. These, we might term the "Island Universes" of the atomic realm. We shall never see them, "until this mortal shall have put on immortality," but we have learned enough of them to fill us with amazement. These are obeying the same laws as the stars in the heavens, and, relatively, are as far from us as they.

So we see that a grain of sand is an interesting symbol of our solar system, and of the universe, having central suns. How strange to think that as we walk over sand, we are treading worlds beneath our feet, and that countless tiny orbs are in every grain of sand.

The History of a Grain of Sand

Let us, in imagination, trace the history of a grain of sand. By some strange creative process, which at present no human being can understand, much less explain, the ether of space, being itself a force, is tangled up by a force which sets it to eddying, and forms an atom of hydrogen, the lightest of all atoms, containing one positive electron, or proton, as the nucleus, and one negative electron as the planet revolving around the proton centre, and one photon.

Twenty-eight of these hydrogen atoms coalesce, and form an atom of silicon, which forms the base for the molecules of silex, or pure sand.

Countless numbers of these molecules, under the force of heat and pressure, form a portion of the crust of the earth. There they lie for ages among other rocks.

At last the titanic forces of the inner earth lift the layers of rock, and break them asunder. One fragment is broken off, and lies, an ordinary bit of quartz, or a grain of sand.

It is quite a family, consisting of several possible smaller ones, each one formed of its molecules, atoms, electrons, protons and photons. This grain of sand-family, is tossed to and fro for ages, crushed and ground into many molecules of sand.

One of these, washed along the shore with others, is shoveled up, and mixed with cement, and is lodged as mortar between two bricks in a building on the crest of a mountain peak, and helped in its way, to hold together a structure known as an astronomical observatory.

Another molecule of sand was mixed with clay, and

placed in a mould, and burnt, and became a part of a brick in the same observatory. Others were mixed with lime, potash and soda, and cast into a furnace, and were poured out as glass, and one became a part of the lens in the great telescope in the observatory; and another helped to form one of the lenses in the microscope in the same building; while another formed a portion of the astronomer's reading glasses; and another a part of the prism in his spectroscope; and another was in the glass of his audion radio detector.

Some lay in the earth, and were seized, and entangled in the root hairs of grain, and by their acid, were transformed into food, and became, one a part of a stalk of rye, and others stalks of wheat. The rye was crushed and ground into pulp, and became paper, forming a book on Astronomy for the astronomer to study in the great observatory. The stalks of wheat were eaten by cattle and were sold from the butcher's block as steak, and ended as cells in the astronomer's brain; and formed a part of the crystalline lens in his eyes.

Others of this interesting, but disrupted family, were washed into the sea, and were acted on by the chemicals of the water, and animal protoplasm, and became the skeletons of minute infusoria. These died, and sank to the bottom of the ocean, and after long ages, formed a portion of the lime rock beneath the ocean. During a convulsive catastrophe of the earth, the rock was lifted to the surface, and became a part of the hill known as, "the place of a skull," or Calvary, and finally supported the cross on which the Prince of Peace gave up His life as a ransom for many.

While all this is a fanciful picture, it nevertheless conforms to the facts as to a few of the uses to which

sand is put. Whether as quartz or sand, or transformed into glass, paper, or the stalks of grain, its atoms, electrons, protons and photons continue the same. They are never destroyed. On and on they go through endless changes, as they have been going since the dawn of creation, and not one is lost, or unobserved by its Creator, who sent it forth on its mission.

If grains of sand can be built up by His fiat, through such forces, and each one performs its appointed functions, how surely the same thing must be possible to the thinking, and willing being who was created in His image.

God sees and knows every grain of sand, and it is no more hidden from Him, than are the greatest suns in the heavens. It performs His will, and has its place as well as Arcturus, or the Island Universe in the nebula in Andromeda.

Surely also man has his place, the niche in God's creation, which He designs that each one of us shall fill. Let no one feel that he has been overlooked, or that he cannot be of use.

Questions for Review

1. How does a view of the landscape from a high elevation, differ from what it would have been could we have beheld it during the earlier geological ages when the sand and soil were in the process of formation millions of years ago?
2. What was the effect of water during those ages?
3. What part did the ice, and heat and cold, play in soil formation?
4. How does water tend to produce earthquakes, geysers, and the like?

5. Is ground up rock sufficient to form good soil?

6. How did the first vegetable forms appear? What were they, and what of their size?

7. How do they disintegrate the rocks?

8. What besides vegetable remains are requisite to form good soil?

9. What about the dust falling to the earth from the air? What is its source?

10. What effects do certain gases of the air have on rocks? What part does sulphur play in this operation?

11. What is the effect of blowing sand? Of waves of the sea?

12. How long has the soil been in the process of formation? Is it being formed now?

13. What part does sand play in the formation of soil?

14. Suppose the seashores were lined with fertile soil, what would happen? If rocks, what?

15. Why is sand used in fortifications?

16. What treasures are sometimes hidden in sand?

17. Of what does sand consist?

18. Of what is pure sand almost entirely composed?

19. What is quartz?

20. What is silica, and how was it formed?

21. Could one count the grains of sand?

22. Would it be possible, by calculation, to make a fair estimate of the number of grains of sand?

23. How long would it take the entire population of the world to count the number estimated?

24. How was sand a measurer of time?

25. How is sand used to illustrate the mercies of God?

26. How is sand used in the construction of buildings? What kind of sand is thus used?

27. What part does sand play in the manufacture of glass? What other ingredients are used?

28. What is sandstone, and what its uses?

29. Whence the colours in sandstone?

30. How does fine sandstone look under the microscope?

31. What of the presence of silicon in nature?

32. What part does it play in forming good soil?

33. What portion does it form of rye straw? Of potato vine? Of wheat straw?

34. How is sand used in horticulture?

35. What about sand and the climate?

36. How is sand used in launching ships? In purifying water?

37. How are calcareous sands formed into stone? What are some of the crystalline forms of such stones, and for what are they used?

38. What are sand dunes? Name some places where they occur.

39. What effects are caused by blowing sand along seacoasts?

40. How are these injurious effects retarded?

41. What of the sand dunes of the Sahara Desert?

42. What of the transportation of sand by rivers? Give examples.

43. Describe the sand river of Africa as seen by Livingstone.

44. How do such rivers affect the rocks?

45. How has sand become a preservative of ancient remains in Egypt?

46. What does the geologist Lyell say of sand storms in Libya?

47. What effect have such storms on the windows along seashores? The effects in deserts like Sahara?

48. What are sand blasts? How are such operations performed? Give them in some detail. What of flexible material and sand blasts?

49. What suggestions do these offer us for our times of testings? What of relaxation in insomnia?

50. How was sand used for blotting purposes? For toilet purposes? For sandpaper?

51. When is sand very impervious to water? What

kind of sand is most so? When would it present an entire barrier to water passing through it?

52. What is quicksand? How does it differ from sharp sand?

53. To safely pass over quicksand, what must one do? Why do objects so readily sink in quicksand, and why is it so difficult to extricate them?

54. How is this a metaphor of life?

55. How are some natures like quicksand? What of much of our social life? Of ingratitude?

56. How is sand, in finding its level, like human nature?

57. What of sand and rhythmic harmonies?

58. What are the Chlandi figures?

59. What of the tendency of iron filings, powdered granules of red lead, and other substances when brought under the influence of an electric current?

60. How does the ability of sand to enter into combinations affect its usefulness?

61. What suggestions does this make for our lives?

62. Mention something regarding the durability of sand.

63. What lessons do its durability, and its shifting nature, have to teach us?

64. Mention some of the changes in the world, if there were no sand.

65. What are locked within one grain of sand? What of the energy?

66. Of what is silicon composed?

67. Why are not the great forces locked in sand more apparent? What is D'Albe's statement?

68. How does sand, and its constituents, remind us of the starry heavens?

69. What are the two universes between which we stand?

70. Try to give the imaginary history of one grain of sand.

71. What suggestions does this offer us regarding our lives?

IV

THE SEA

IN the preparation of the earth for the habitation of man, and the animals, we have already considered how essential are sand and fertile soil. But it would be absolutely impossible to have fertile soil if there were no water. There could be no vegetable or animal life, and probably little or no sand.

The source of all water on earth is the sea, and so it is worthy of our somewhat extended consideration in these nature studies.

It would be very difficult to find in any literature so perfect a description of the wonders of the sea, and a storm on it, as is given in a few sentences in the 107th Psalm. "They that go down to the sea in ships, that do business in the great waters; these see the works of the Lord, and his wonders in the deep. For he commandeth, and raiseth the stormy wind, which lifteth up the waves thereof. They mount up to the heaven, they go down again to the depths; their soul is melted because of trouble. They reel to and fro, and stagger like a drunken man, and are at their wit's end. Then they cry unto the Lord in their trouble, and he bringeth them out of their distresses. He maketh the storm a calm, so that the waves thereof are still. Then they are glad because they are quiet; so he bringeth them to their desired haven."

The Extent of the Sea

There is not a spot on earth which at some time was

not covered by the sea. And the dominion of the ancient ocean has been surrendered to the land very grudgingly, and that only in a lesser degree. Out of the 197 millions of square miles of the earth's surface, 145 millions of miles are still under the rule of that ancient Neptune, while 52 millions of square miles, or one-fourth of the lithosphere are allotted to the dry land.

We gain a new conception of the size of the earth when we see the ocean. Its vastness is awe inspiring. It seems to be boundless. It is a fit symbol of eternity, and not alone to those who see it from its shores, but to those who have crossed it many times.

It is majestic and alluring; beautiful when calm, but fearful and awe inspiring when it is aroused from its serenity, and its mighty billows, mountain high, rage over its surface, and break with a loud roar upon its shores.

Twice when the author has crossed the ocean storms raged for several days. The mighty billows rolled over the ship, and sometimes the water was several feet deep on the main deck. All hatches, and open places were fast closed, and life lines ran the length of the ship, so that any of the very few passengers who were able to be on deck, might cling to these, and so avoid the danger of being washed overboard. A sail had been hoisted on the square rigging so that it would steady the ship in its fearful rolling in the waves.

Occasionally a great wave, like some mad monster, would smite the ship, and cause it to tremble from stem to stern. Quite frequently the bow of the ship would plunge down into the sea, and the stern would be lifted high into the air, and the propeller being out of the water, would race madly, to the distress of the

sick passengers in their berths, and shake the ship its whole length, somewhat as a great whale might flap its tail when angry.

One such day, when two of us were able to get out on deck, we clung to the life line, and worked our way to the high forward deck, where the waves were not rolling over the ship, and we lay on our faces holding to the great rings through which the anchor chains ran, so as not to be tossed off the ship in its fearful rolling. Sometimes the main yard, which held the sail, would almost touch the sea, when the ship rolled over on its side, first one way and then the other. Several times we remarked: "See that great wave coming toward us! It looks as high above us as the yard-arms on the mainmast."

It was a grand, but fearful sight, and one which having been experienced, leaves no longing within one to have it repeated. For four days that storm raged, and on a subsequent occasion, on leaving the north of Ireland, the ship encountered an even worse storm, and it was twelve days ere the ship anchored in the calm waters at quarantine in the New York bay.

What an accurate description of the experiences of men in a storm on the sea is given in the 107th Psalm which we have quoted above. "They that go down to the sea in ships; that do business in the great waters; these see the works of the Lord, and his wonders in the deep."

It is fortunate for humanity that the sea covers so large a portion of the earth's surface, about three-fourths, and the remaining one-fourth is largely taken up by lakes, rivers, and underground streams.

How much we are dependent upon water is indicated by the fact that 99% of most living bodies are com-

posed of water; that the earth's atmosphere contains billions of tons of water, and that every existing organism is continually giving off watery vapour.

Evaporation of Sea Water

The whole body of the ocean is composed of molecules of water. Later on we shall refer to this in fuller detail.

These molecules of the water, like those of all other substances are quickened in their motions by heat, and slowed down by cold, until at absolute zero their movements cease altogether.

The heat of the sun falls upon the ocean, expanding the surface water, separating the molecules further apart, quickening their motions, and so the heated molecules of water are continually springing off into the lighter, thinner gas of the atmosphere.

The warm air separates its molecules affording more room in which to welcome the molecules of watery vapour. The heat of the air keeps all these molecules of water dancing about so rapidly that they cannot touch, and come together, or coalesce, and form drops of rain, which they do when the temperature falls sufficiently, and then they draw near to one another, and grapple, and they become rain or snow.

The molecules of watery vapour, being light, float about in the atmosphere. The air over the land becomes more rapidly heated than that over the sea, as the sea water absorbs more heat than does the land, and it also reflects less into the atmosphere. And so the cooler air over the sea rushes toward the land, where it has more room, or where the pressure is less, and this causes the trade winds to blow steadily toward the land during the day. These winds carry the

vapour along, and when it becomes cool, the molecules of water draw together and settle upon particles of dust which are floating in the atmosphere, and which become the centre of rain-drops, or of snowflakes or of hail.

And thus the land is refreshed and fertilized, and all living bodies are nourished by water derived almost entirely from the ocean. Were it not for the ocean, soon all our lakes, rivers and springs would dry up.

The Extent of the Sea Important

If the ocean were reduced by one-half, it would diminish the amount of evaporation, and the rains and the rivers and springs and underground sources of water, by the same proportion, and that would reduce the possibility of man's existence on earth by one-half.

At the command of the Creator, some mighty forces must have convulsed the earth, causing the upheaval of what were to be the future continents, and at the same time the depression of the more extensive portions, forming the hollow deeps into which the waters flowed, forming the oceans.

The upheavals and depressions of the earth's crust, causing the numerous faults in the strata of the rocks, as are often seen on the shores of the ocean, lakes and rivers, must have been attended with terrific convulsions, such as have been witnessed by no earthquake during human history.

The most fitting language in which to describe the occurrence in forming the ocean and the dry land, is given in the 104th Psalm. "O Lord my God, thou art very great. Thou art clothed with honour and majesty. Thou coverest the earth with the deep as

with a vesture; the waters stood above the mountains. At thy rebuke they fled. At the voice of thy thunder they hastened away; the mountains rose up, the valleys sank down, unto the place which thou hast founded for them. Thou hast set a bound that they may not pass over; that they turn not again to cover the earth."

From what we have already seen, as to its being the chief source of the moisture of the earth, and of refreshment and sustenance of all living things, but also from its many other beneficent operations, which we shall further consider, we cannot understand how it is possible for a thoughtful or thankful person to fail to see it as a work of design, in which God planned and wrought for the good of all His creatures, particularly for man, whom He created in His own image, and whom He purposed should be the happy, holy and grateful child of his Father in heaven.

The sea is the great purifier of the earth, and of the air also, though to a less degree. Salts and other minerals have preservative qualities. It is a well known fact that they retard, and even prevent putrefaction. Their presence is sufficient to perform this beneficent operation on the earth.

Minerals in Sea Water

The total percentage of salt in the sea water is 3.527; and the percentage of the solid mineral substances in sea water is found to be as follows:

Common salt, 75.786%
Chloride of magnesium, 9.159%
Chloride of potassium, 3.657%
Sulphate of lime, 4.617%
Sulphate of magnesia, or Epsom salts, 5.597%
Bromide of sodium, 1.184%

In addition to these ingredients, the sea water has traces of iodine, silica, fluorin, carbonate of lime, carbonate of magnesia, phosphoric acid, gold, silver, lead, copper, arsenic, and some dissolved atmospheric gases.

The rocks of the earth are all more or less porous. They are composed of tiny grains, crystals or particles, and between these are channels, or interstices, into which the water forces its way when it falls as rain. The underground rocks are thus saturated with water, which has a tendency to dissolve them. The various mineral springs, which contain large proportions of minerals, are an example of how water will dissolve rocks, and become saturated with various minerals.

Every spring, brook and river removes some mineral from the rocks, and carries it to the ocean, and so every element contained in the rocky crust of the earth is found in the sea, but is held in solution, and so the presence of salt and other minerals in the ocean is increasing in amount.

All parts of the sea are not equally salty. In the mid ocean it is generally from three to four per cent., but in the Mediterranean, and inland seas, where the evaporation is greater, it is from eight to twelve per cent. In the polar seas, where there is much less evaporation, and where melting ice imparts great quantities of fresh water to the ocean, it is less salty.

The total salt of the sea would cover seven million square miles of the earth, or more than one-eighth of the land surface, one mile deep. Vast quantities of salt are being reclaimed yearly from the sea. In one place in California, there is a plant which has concentration ponds and harvesting fields which occupy 15,000 acres. The water from the sea is evaporated in these from May to October. At that point the water con-

tains about four per cent. of salt, and this water is evaporated by the sun until it contains about nineteen pounds of salt per cubic foot. After the salt is precipitated out, the remaining water is pumped back into the bay. Many thousands of tons of salt are thus secured from the sea at this plant each year.

The sea is the great purifier of the earth, and of the air, though to a less degree. Along with all the minerals which are carried from the land into the seas are also the refuse, decay, and various poisons. These are attacked by the salt, and other minerals of the water, much as brine attacks the cells of meat covered with it, and preserves it, so these minerals prevent putrefaction of those things which are carried into the sea.

Currents in the Sea

The vast currents, or veritable rivers, which flow through the ocean are another source of the purification of its waters, and of the atmosphere above it.

These currents are the result of a combination of causes. The chief of these are, the revolution of the earth, the heat of the sun, the salinity or density of the water, and the configuration of the continents. Since the ocean currents change the climate of the earth, and the abode and welfare of man, they are worthy of our careful consideration.

First, their causes. Under the high temperature of the direct rays of the sun in the tropics, the water of the ocean becomes heated and expands, and being lighter rises to the surface. The cold heavier water at the poles creeps toward the equator, while the warm lighter water moves toward the poles. Hence there are two classes of currents in the ocean, the tempera-

ture or surface currents, and the compensation surface currents. If there were no extraneous causes, there would be a direct surface movement of the warm water from the equator toward the poles, and a compensating movement of the cold water from the poles toward the equator.

It is said that in the Atlantic and Pacific, in the equatorial regions, not only is the surface water very warm, but that a temperature of 40° is found as deep down as 1,800 feet, while at a depth of 15,000 to 18,000 feet the temperature is from 32.4° F. to 33° F., or a very little above the freezing point of fresh water. And so those bottom temperatures are very little different from that of the polar regions, and hence there is a circulation of the water vertically, as well as horizontally.

The currents of the oceans are unlike the shifting currents of the atmosphere, which we term winds, in that the former year after year run in established channels, as much so as the rivers on the land, and they are often termed rivers in the bed of the ocean.

In the north Atlantic, the initial movement of the water is caused by the rotation of the earth from west toward the east, and the water being mobile, tends to move from the east toward the west. The earth being largest at the equator, the movement is much greater there, while at the poles it is stationary. On the equator the movement is 1,036 miles an hour; in latitude 15° it is 1,000 miles an hour; in latitude 30°, northern Florida, the velocity eastward is 897 miles an hour; in latitude 45°, which is about the northern boundary of the state of New York, the velocity eastward is 732 miles per hour, and in latitude 60°, southern Greenland, it is 518 miles an hour.

This rapid movement of the earth toward the east at the equator, imparts the first great impulse to the waters to move westward toward South America. This current, or river in the ocean, is called the South Equatorial, and in the summer has a temperature of 84°, and moves at two nautical miles an hour. Near the South American coast, it forms two branches, one moving south and the other northwest through the Caribbean Sea, and around the Gulf of Mexico, where it attains a temperature of 88° in the summer, and passes through the Straits of Florida, about twelve miles out, and flows northward as the Gulf Stream, perhaps the largest river on earth, and moves in a majestic curve past Hatteras to the Grand Banks of Newfoundland, its direction being regulated by the land contours.

The Gulf Stream

" The hydrographic department of the United States navy has devoted much study to, and made many surveys of these currents. One of the reports says: ' The Gulf Stream is undoubtedly the greatest and mightiest of all terrestrial phenomena. There is a river in the ocean, its fountain in the Gulf of Mexico, its mouth in the Arctic Ocean; a current more rapid and conveying more heat than would a stream of molten iron the size and velocity of the Mississippi.'

" The late L. C. Riker reported: ' Ninety billion cubic yards of water, at more than seventy-five degrees Fahrenheit, pass Cape Florida northward every hour, liberating more heat, in being cooled to fifty-five degrees, than would be produced by burning two million tons of coal every minute. It carries its waters northward, easily distinguished from the surrounding ocean by its

deep blue colour.' 'Between Cape Florida and Bimini, the Gulf Stream has a width of about forty miles, and is about twelve hundred feet deep.'

"There is an Arctic current which sweeps down along the coast of Greenland out of Baffin Bay, and passes the coast of Labrador and Newfoundland, bearing with it vast fields of ice; this current attacks the Gulf Stream over the Great Banks, in a never ending struggle for the mastery. The winds often hold the balance of power. The struggle ends in either cold or warm bands extending across the Banks. Part of this Arctic river, with its average temperature of thirty-two degrees, continues its attack even to the source of the Gulf Stream, where it passes between Bimini and the Florida Cape, and goes beneath the stream, and even chills it in its very cradle in the Gulf of Mexico. If the Arctic current should gain complete ascendency, it would transform the whole eastern coast of the United States into a land as desolate as Labrador.

"The Gulf Stream like a mighty river of blessing sweeps steadily onward; it divides into different branches, but in the main moves round the British Islands, through the North Sea, downward off the west coast of Europe and Africa, past the Canary Islands, and westward across the Atlantic; then it divides, part entering the Caribbean Sea, the other branch moving north past Cuba and on in a circular form past the Azores, and again turning south and then west encircling the Sargasso Sea, and ending in rips and eddies after having formed a mighty spiral. Other stupendous rivers sweep in circular and spiral forms around the south Atlantic, Pacific and Indian Oceans." [1]

[1] See "Through Science to God," pp. 117–118. By the Author.

The flow of these rivers in the ocean bed is most interesting and important. The cold currents flowing from the poles are at the bottom, or deep down in the ocean, while the warm ones are near the surface. It seems strange to see the seaweeds and other objects on the surface of the water moving steadily in face of a gale blowing from the opposite direction.

Navigators have been known to meet a strong head wind and heavy sea, and yet their bark moved majestically on because a large bucket-like object was sunk into the sea to which a line was attached, and this falling into the submarine river, carried the object along with it, and towed the boat forward despite the opposing stormy surface winds and waves.

Icebergs

Icebergs are about one-twelfth of their mass above the water, so that one which is one hundred feet above the water extends 1,200 feet below it. It is an interesting and well known fact that they are frequently seen floating directly opposite to the direction of the wind and waves on the surface. One may break away from a glacier on the shores of Greenland, and float majestically southward, until it meets the Gulf Stream, and then its course is changed, and it begins to move in a different direction. A northeast gale may be blowing, and the waves beat upon it, but in the teeth of both, it moves solemnly onward.

There is an often quoted statement by Captain Duncan, the master of the English whale ship *Dundee,* as follows: " It was awful to behold the immense icebergs working their way to the northeast from us, and not one drop of water to be seen; they were working themselves right through the middle of the ice. They were

moved by an invisible power which no surface facts could account for."

They extended far down into the waters, hundreds of feet, and the powerful ocean river, into which their huge bulk, twelve times the size of what was above the surface, imbedded themselves, carried them irresistibly forward, through vast fields of surface ice, against contrary winds.

They, and boats, being steadily forced forward in the face of opposing storms and winds, remind us of what is possible to men and women who have to meet the oppositions and storms of life. The tendency is to drift with the surface currents. They may yield to their environment and its direction. But there are others, in all walks of life, who have ever met fierce head winds, and yet they move steadily and calmly onward toward the desired haven. There is a reason. Deep down within every human being there is a current which moves him Godward, and if he surrenders to it, it moves him toward happiness, and the highest achievements which are possible to him. That heavenward trend is not on the surface. It comes to all as the result of the atoning sacrifice of Christ. It is the Divine Spirit convincing and convicting, regenerating and guiding the one who is willing to heed His powerful movings within. Some, alas, never subject themselves to the trend of the deep movings within them. The waves and storms beat upon them, and they are moved to and fro by every outward force which bears down upon them. They cannot understand how their neighbour can move calmly onward, despite all outward obstacles. The latter are anchored to the deep heavenward Current, which always moves toward self-control, purity and heaven.

Ocean Tides

Because of the pull of the sun and moon on the earth, and on all things terrestrial, a wave, or more truly, an upheaval of water moves round the earth from the east toward the west, like the waves passing over a field of standing grain. When the sun, the moon and the earth are in the same straight line, the highest tides occur. The moon being so much nearer to the earth than the sun, only 240,000 miles distant, it exerts three times as much influence on the tides as does the sun, for the gravity or attraction of a body decreases with the square of the distance, and also in proportion to the mass.

In the open ocean the height of the tidal wave is generally not over two or three feet, but at many places, because of the configuration of the land, it attains many feet. For example, the tide sweeps into the Bay of Fundy one hundred feet in height.

The rate of speed of the tidal wave is affected by the same causes. Across the southern ocean it moves at nearly a thousand miles an hour, while in other places, as the North Sea, it is less than fifty miles an hour.

The tides, like the rivers and currents in the ocean, retard the tendency of the waters to stagnate, and aid in its purification. They are of great value to the land, as they sweep in upon the shores, removing the refuse which collects there, and afford the great advantages of a harbour in many parts of the earth. London would never have developed to its present great importance commercially had it not been for the tides.

Truly the wisdom and goodness of God are seen in that He so constituted the moon, that though it is so

far distant, it should exert a mighty and unremitting power for good, by lifting the waters of our planet into magnificent and periodical waves, to fill our harbours, to wash our shores with majestic rollers, and to maintain a regular pulse in the great ocean heart, by which its life and purity are maintained.

There is a wonderful balance between the land and the sea: far greater than we can trace or realize. Were the earth all dry land, though it had numerous rivers, lakes and small bodies of water, there would be no such fertility of the soil, and no such safety and healthful conditions for the comfort and security of man, as now exist. In fact it is very doubtful if he would have been able to long exist on earth.

The Seascape

When standing on the shores of the ocean, and looking out over the vast expanse, as the waves come rolling in at our feet, and the ships are seen to toss like toys on the great billows, we little realize that there is a seascape as varied and as grand, and as entrancing in its beauty, as anything which we see in the landscapes on the dry land.

There are mountain ranges, with their vast peaks, and gorges and cliffs, and valleys and plains, as entrancing as anything which we see above the waters.

Very recently, in 1929, a new mountain range, or ridge, has been discovered in the Pacific Ocean, 660 miles west of Chile. It is ten miles wide, and rises ten thousand feet above the bed of the ocean, and yet its top is four thousand feet below the surface of the water. It is called the Merriam ridge, or range, in honour of the president of the Carnegie institution in Washington, on whose ship the discovery was made.

As we have already mentioned, there are rivers as great as the Mississippi, or the Amazon; there are caves and grottoes, groves and arcades of sea-forests; their caves and cliffs and precipices are embossed with green and gold seaweeds, and decked and trellised with sea flowers of all kinds. The caves and grottoes are lined with blue lights, and natural arches festooned with all colours of bright glowing vegetables, and living creatures.

There, too, are the blank spaces, which correspond with our deserts, vast tracts devoid of life. Sea birds show their instinct and sagacity by parting company with the ships which they have followed for days, so soon as this " Arabia Petra " of the ocean is entered.

" The grand old sea hides wonders
That never met mortal eye,—
Bright bowers that never have rustled
To soft wind's dreamy sigh;

Strange groves of mystical beauty;
And flowers of rainbow hue,
Bloom wild in those old sea-gardens,
All under the water blue!

Oh, the floral festoons of magic
That curtain those pearly caves
Where the water-spirits revel in splendour
All under the drowsy waves!

Wave on your beautiful tendrils
In your gardens wild and free,
Caressed by gleaming waters
Of the grand old heaving sea! " [1]

[1] Edwin Waugh.

Forests in the Sea

In the sea grow vast forests, and mighty plains are covered with a variety of vegetation which, for brilliancy of colouring, is not surpassed by anything on earth. There are to be seen the dim, strange, ghostly outlines of algæ; garlands of plumarias and other streamers of seaweed. Some of the algæ are striped with blue and red and green. Some of the vegetation are like great trees which, torn from their holdings, float on the surface for miles in length, like a great brown or purple sea-meadow, to the annoyance of seamen. One plant may be a mile long.

Edward Forbes says: "On the northwest coast of North America, there is a tangle named Nereocystis, having a stem which measures, when full grown, 300 feet in length, and bears at its extremity a huge float six or seven feet long, shaped like an enormous cask, covered by a tuft of more than fifty forked leaves, each of them thirty or forty feet long. Yet all this mass of vegetation is moored by a stem as thin as a whip-cord."

Then he refers to the Macrocystis with its astonishing length of nearly a thousand feet.

The ocean trees are in great contrast with the land trees which have to contend with the rude blasts, and bear the weight of their branches, and foliage. Hence they require roots as strong as grappling irons to fix them in the soil. Also, they must derive their sap, and much of their nourishment from their roots. But the ocean forests are swayed to and fro so gently in their watery element that they require only the very slenderest fibres to attach them to the bottom, and they do not depend upon these for moisture or nourishment.

The ocean which we so often gaze upon is only the

cover, the blue canopy of a wondrous world of beauty. Our greatest and proudest hills and cliffs, or large portions of them, are chiefly composed of sea animals. There are 8,000 different kinds of fishes, and 4,000 or 5,000 families of crustacea, near or distant relatives of theirs.

The ooze is slimy mud or spongy soil of calcareous matter covering the bottom of the ocean, and very largely composed of the skeletons of foraminifera, a primary division of the animal kingdom. This ooze produces the chalk formations of the earth. Schleiden maintains that a single visiting card, when covered with a white layer of chalk, represents a zoölogical cabinet containing nearly 100,000 shells of animals.

Life-Zones in the Sea

There are no boundary lines which separate the animals inhabiting the ocean-world, no mud walls, no locks or keys, no police, or taxes or protectors. The mighty deep is an unfenced territory, with plenty of elbow room. No one of the denizens jostles against his neighbours, or grumbles at the limitation of his acres. Three-fourths of the globe is their farm.

And yet down there are what are similar to stories in a house, and each story is occupied by its own peculiar families, vegetable or animal. Sometimes the occupants of the lower, or basement apartment, may go on a visit to their friends in the flat just above them, or in the topmost flat, and also the occupants of the shallow apartments may descend the watery staircase and visit their neighbours in the darker and chill rooms below them. And yet there is a distinct order, and different zones are found in the seas as well as up the sides of a mountain on the dry land.

While there are roving fishes, and roving plants and roving shells, those up in the aeroplanes to-day and down in a mine-shaft to-morrow, yet there are carefully observed zones, which are the abode of both plants and fishes in the ocean depths. Peculiar types inhabit each of the zones in depth, and are confined to their destined regions, while others are common to two or more zones, and some appear to be hardy enough to live in all of them.

The first zone is the "littoral" or shore line, the sea life nearest the shore and surface of the water. These are the plants and animals which require the most air and light, and warmth, and more rain, or soft water.

The second zone is the main region of the seaweeds. Here are all the surprisingly beautiful algæ, with many tints, arbours, hedges, and meadows of them. The fishes in this region are generally of bright colouring. The angel and butterfly fish, and others, are marvelously coloured. Some idea of these beautiful creatures, and of their environment, may be obtained by looking at the coloured plate on "Living Rainbows of the Reefs," in the new 14th Edition of the Britannica Encyclopedia.

This is the region, above all others, which is seen to be swarming with life, when one looks down through the clear waters into the waving forests of broad-leaved tangles. There are animals of every possible colour, sporting among their foliage, darting from frond to frond, prowling among their gnarled roots, or crawling with slimy trail among their polished, bronzy expanses.

The third zone is the coralline, and reaches to the depth of 180 feet. This is more the animal than the plant region. The animals, however, look like beautiful

plants, with stems and blossoms. They rear their graceful feathery branches, and form miniature gardens of fairy-like delicacy and beauty. Some in this region exceed in beauty the fairest flowers in the gardens on the land.

The fourth is the zone of deep sea corals. This is the one least tenanted. This goes as deep down below the surface as the mountains on the shores rise above them. The coral here are skeletons. The coral polyp could not live at this depth.

The ocean floor, as it is termed, is the floor of the lowest story of our imaginary sea-castle, and covers an area of 140,000,000 square miles.

In the lower regions where the depth has been estimated at eight miles, the solar rays cannot penetrate. There is no light, and so no heat from the sun. Awful indeed must be those regions of darkness and silence. Some say they are ten or twelve miles below the surface.

In the " Voyage of the Challenger," it says concerning the marine animals at great depths, " The fauna at great depths was found remarkably uniform. It would seem that the enormous pressure, the utter darkness, and the difference in chemical and physical conditions of the water, in the proportions of its contained gases, do not influence animal life to any great extent. The fact is established that distinction of living beings has no depth limit, but that animals of all the marine invertebrate classes, and probably fishes also, exist over the whole floor of the ocean. But generally the number of species and individuals diminishes after a certain depth is reached. What is usually the abode of vegetation is practically limited to depths under one hundred fathoms," six hundred feet.

Beauties in the Sea

Surely God loves that which is beautiful and harmonious, or better, He has expressed Himself in things everywhere which are harmonious and beautiful. He has not only decked the earth and sky with beautiful forms, and caused all nature to move in perfect rhythm, and to sing in all the colours, where man can behold and hear them, but wonderful beauties of nature are hidden away where no human eye can see them, and no ear but His can respond to their delicate harmonies.

Deep in the forests, and in the caves, and down in the depths of the earth to which no mine can reach, there are beauties of crystal forms, and delicate traceries such as no human artist can equal. Away among the snows and ice at the polar regions, inhabited only by the penguin, and other feathered and fur-bearing creatures, are beauties which are unsurpassed by anything seen by man.

In the ocean depths there are colourings rich and rare, so striking and beautiful that their equal can hardly be found anywhere on the dry land.

The prevailing colour of vegetation above the sea is green, which is produced by the action of the chlorophyl formed in the grass and leaves under the influence of the rays of the sun. Green is a soothing, nerve-resting colour which protects man, and prolongs his life and usefulness on earth. If the grass, and leaves and sky were red, he would soon break nervously, and die.

In the sea, the vegetation which is not touched by the actinic rays of the sun, we do not see the green colour prevail, but all the prismatic colours, and every tint and shade are manifest. The deep, strong colours shade off into the delicate tints.

And the same is true of the animal life. On the upper surface of the earth, in field and forest, on plain and mountain, we see animals dressed in more or less gay colours, particularly the birds. But generally they conform to the colouring of their surroundings. On the ice fields of the polar regions, the birds and bears are generally white, or a light grey. In sandy deserts, brown, the shade of the soil, is the prevailing colour. In the tropics, with heavy rainfalls and luxuriant vegetation, the birds are green, or of deep colours.

We call this conforming of the animals in colour to that of their environment, protective colouring. They take the shades of their surroundings that they may not be so readily seen by their enemies.

Then, too, we are informed that the males of birds and animals deck themselves in gorgeous colours to attract the attention of the opposite sex. The more beautiful they are, the more easily their possible mates would be won over to them.

Whether such notions prevail in the deep sea, among the fishes and all manner of life there: in other words, whether they desire the approval of their appearance, we cannot say. But we know that the peacock, in all his glory, is not more beautiful than multitudes of those creatures which live and sport in those regions beneath the waters, far beyond the range of man's vision.

Beautiful flower gardens seem to have burst into bloom in those dark regions; they are animal-rose-bushes, and daffodils, and violets, and honeysuckles, and every variety of coloured flowers of the animal world. They cannot retain their beauty when removed from their native element, but fade almost instantly under the rays of the sun.

Why should the Creator hide away such beauty in

the ocean depths, miles down below the surface, where no human eye can see it, unless it is because He Himself can express Himself only in things which are beautiful and harmonious?

Beauty and harmony in the physical suggest the same qualities in the mental and moral realms. No thought of discord can exist in His mind, as there can be nothing inharmonious in Him who is love. And He desires only those qualities in us, because anything else is debasing and destructive to us, ruinous to our peace, and dangerous to our life.

His beauties and harmonies are object lessons placed about us on every hand, above, below, at our right and left, and even within our bodies, to suggest to us thoughts of harmony, and beauty, which are a close kin to faith and love. Whittier sang:

A GIFT

Of ocean flowers,
Born where the golden drift
Of slant sunshine falls
Down the green, tremulous walls
Of water, to the cool, still coral bowers,
Where, under rainbows of perpetual showers—
God's gardens of the deep—
His patient angels keep
Gladdening the dim, strange solitude
With fairest forms and hues, and thus,
Forever teaching us,
That beauty, in, and of itself is good.

The Gurnards have been described as possessing remarkable beauty, and are termed "peacock butterflies." Their rich brilliant tints vary with every graceful movement. Their pectoral fins, the varied

colours of which melt into a fringe of cobalt. The creature is a blaze of beautiful tints. This is not the only fish, by any means, which possesses the butterfly resemblance. These have already been referred to on a previous page.

Professor Schleiden says: " The most luxuriant vegetation of a tropical landscape cannot unfold as great a wealth of form; while in variety and splendour of colouring it would stand far behind this garden landscape, which is strangely composed exclusively of animals and not of plants. Whatever is beautiful, wondrous or uncommon in submarine life, is crowded into the warm and crystal waters of the tropical ocean."

Life in the Deep

The theory once held that the stupendous pressure of the sea depths made it impossible for life of any kind to exist in those regions, has long since been abandoned. Life of all kinds, and varieties, exist and sport in the submarine deep, from the equator to the poles, and from the surface to those depths where the only light is the phosphorescent glow of the creatures themselves.

Some of them have scales which sparkle like silver, some as if clad in a cloth of gold; some quick and graceful in their movements, and some lumbering and disporting in awkward fashion in a bath of ultra-marine; some cleaving their way with consummate grace; but most, it must be confessed, are busy satisfying the demands of their appetite, and not by any means fastidious about appropriating, for this end, a neighbour.

While the deep sea vegetation grows scantier and scantier as we descend, and disappears altogether, at about 300 feet, it is very different with animal life.

As in high mountainous regions, animals can adapt themselves to outward circumstances where it is impossible for vegetables to thrive, so in the ocean: animals can survive privations longer than vegetation. And so beautiful animal structures, chiefly silicious, have been brought up, by an apparatus, in the deepest sea soundings which have been known, off the coast of Japan.

Life Struggles in the Sea

Sea life, with rare exceptions, revels in shady depths, avoiding the light, while they feed upon the weaker creatures about them.

It makes one indignant to look down into the clear water of the sea, and to see how ruthlessly the larger and more powerful denizens of the marine world will attack and destroy their weaker neighbours. They go about their task with ruthless swiftness, and deadly accuracy. One is inclined to exclaim, " Why not live, and let live! "

But then, we are reminded that such is the spirit manifest among us, who stand at the head of life on earth. There is an endless struggle to get possession of the things of others, sometimes by force alone, sometimes by the skill of keener thinking, and sometimes by persuasive deceit. And, not yet have we learned to cease destroying one another, and must make our solemn treaties, with one another, ever hoping that in the testing time they may prove something more than a " mere scrap of paper."

Doubtless these deep-sea creatures feel more secure in the gloom, but they also enjoy it more thoroughly. They were given natures which cause them to feel more at home away from the light, and perhaps many of them

feel a thrill of delight as they descend into the regions a mile or two below the surface, which is akin to our sensation of vigour as we ascend high hills, and breathe the bracing ozone, and take in the enchanting sights.

We enjoy the rush and go, the noise and bustle, and congregate in crowds by the hundreds of thousands in our cities. But there are no cities among the teeming inhabitants of the ocean, and probably their population vastly outnumbers that of us men, as their habitation is immeasurably greater than that occupied by us.

We live on the surface, and occasionally, and briefly, delve into the mines, or mount up into the air, but quickly return to our home, the earth's surface. But they live in the whole of their world, from its bottom to its top, as well as over its length and breadth.

It is as if it were as convenient and natural for us to live at the top of our atmosphere, or in its centre, as at the bottom, where we now reside. We then would look up, and see our friends and neighbours, some of them two or three miles up, and others near the top, ten or twelve miles, and the intermediate spaces would be filled with them going through all manner of circumlocutions. It would be a strange, fantastic sight to us, but is an ordinary one to the inhabitants of the marine world, which lies almost beneath our feet.

While those creatures avoid the light, they are many of them, a light unto themselves. They are moving lamps, often dim and dull, but many of them, like the medusæ, seem like a shower of marine fireworks. In the southern seas the luminosity is often very brilliant, and it gains in vividness through the multiplicity of larger medusæ and mollusca, which adhering together so as to form long tortuous chains, shine beneath the waves like fiery serpents.

Phosphorescence in the Sea

As one stands on shipboard on a dark night, and looks at the water at both bow and stern of the ship, she seems to be plowing through billows of fire. Countless multitudes, millions upon millions of luminous Infusoria, so small that a cubic inch of water will contain perhaps fifty thousand of them, are being stirred up from their sleep of inactivity. And, like some people who do not like to be disturbed, they show their resentment in a bit of fiery temper. They leave a luminous track behind them, which reminds us of the tail of a comet, a nebulous cloud of light.

Very much has been written on the phosphorescent light emitted by sea animals, many of which are so small that they can scarcely be discerned by the naked eye, and a good microscope is necessary to discover the creature, and the peculiar nature of its luminosity.

Dr. Carpenter says: " What can be the design of this remarkable phosphorescent light produced mainly by such well-nigh invisible creatures as the Noctilucæ miliaris? Answer. As light, of course, diminishes so very considerably in the passage of its rays through water, at a certain depth, the sea is profoundly dark. He who gave the wingless stay-at-home female glow-worm phosphorescent light by which her winged male could be attracted homewards in the night, he being always in the dark, has designedly bestowed on the microscopic inhabitants of the sea the power of emitting light at ocean depths by means of which the curious inhabitants may be conducted through a world of gloom, where the light of day no longer penetrates into the caves and valleys of the sea."

Darwin thus describes the appearance of some of the

phosphorescent medusæ. " The scene was one of awful grandeur: the sea being turned to phosphorus, the heavens being turned to blackness, and the stars going out."

Another has described the magnificent spectacle afforded by a whole shoal of molluscoidea, Pyrosomes, doing full justice to their name, " fire bodies." " The ship proceeding at a rapid rate, continued an entire night to pass through distinct but extensive fields of these mollusca; floating, and glowing as they floated, on all sides of her course. Enveloped in a flame of bright phosphorescent light, and gleaming with a greenish lustre, the Pyrosoma in vast sheets, upwards of a mile in breadth, and stretching out until lost in the distance, presented a sight the glory of which may be easily imagined. The vessel, as it cleaved the gleaming mass, threw up strong flashes of light, as if plowing through liquid fire, which illuminated the hull, the sails and the ropes with a strange unearthly radiance."

Canon Bateman writes: " The vessel seemed sailing on a sea of fire. Before, behind, and on either side, so far as the eye could reach, and covering a space of at least twenty miles, the light extended, and the ship had been sailing over it, for at least an hour. There was no moon, the night was, in itself, pitch dark; and yet it was as light as day. I ran down to my cabin and brought up a very small type Bible, and opening it, read with perfect ease, and aloud, some verses from the prophet Ezekiel which had casually opened." [1]

Living Lamps

Numerous of the larger creatures are also luminous, the fins and scales of which seem to throw off particles

[1] Reminiscences, p. 46.

of gold, as if some sea-goddess were exhibiting her jewelry, or a pyrotechnic his cascades of fire.

Beyond a certain depth, the sea is in perfect darkness so far as any external light penetrating to those dismal regions, but He " whose way is in the sea, and whose path is in the great waters," gave His creatures in those profound depths the means, in themselves, of lighting up the gloom of their home.

It is very suggestive of the thought that He provides a light for every dark spot. When the light of earth fades, and no illumination is afforded by our friends, and all about is dungeon darkness, and every source of external light has been cut off, He has so created us that then a light from within ourselves can break forth to show us the path. Just how it comes we may not know. It may be as mysterious as the light which streams forth from the creatures of the sea. Further reference will be made to this later.

Some of these creatures emit light only after stimulation, either mechanically or chemically. The slightest breeze is sufficient in many cases to cause the sea to glow. In some cases the light is dependent upon the volition of the animal, or is the result of reflex stimulation of the sensory nerves. Many luminous organs retain their power after the death of the animal. In any case it seems to be due to the transformation of vital into radiant energy.

This " abyssal theory " of light for the deep, dark regions of the sea, is due to very different causes than the phosphorescence of minerals, like platinocyanide of barium's response to the X-rays, and of zinc sulphide to the rays shot forth from radium. Such light, manifest by numerous minerals, is due to the response which their atoms make to the waves of light which fall upon

them. The atoms are resonators, and may be considered as small molecular tuning forks. And as one fork will sing response to another's vibrations of the same key, or to any other vibration with which it is in unison, so the atoms of bodies will often vibrate light waves when their keynote is struck, and this light is termed fluorescent, if it lasts only during the impact of the moving waves; and phosphorescent, if it continues for some time after the source of the moving energy is removed, as with luminous paint, calcium sulphide, glowing in the dark for a long time after being exposed to the sunlight for a moment.

Men Shine

It would seem as if man is endowed with the possibility of phosphorescence similar to that manifest by marine creatures, and also by the atoms of minerals which glow under the impact of light waves.

The human body has often been known to emit a phosphorescent glow. Certain chemical changes in the body may cause this, as the result of disease, or it may be caused by mental effects produced in the body. Moses had such a luminous face when he returned from a prolonged association with God on Mount Sinai. And Stephen, in the spiritual fervour of his vision of Christ, during his last moments, had a face which shone as it had been that of an angel. The whole person of Christ, on the Mount of Transfiguration, radiated light like that of the sun.

But there is an inner light, which may not be manifest in the physical sense, which nevertheless radiates from men and women, and it affords as true an illumination for dark times to both themselves and others, as if it poured forth in visible rays from their body.

This is a light which illuminates the soul because of response to the Father of lights. It is the result of surrender to Him, and being brought into tune with Him. Then such an one has the light of life, and radiates it so long as it falls upon him, and he keeps himself surrendered to the Author and Giver of light.

Then, too, as with the denizens of the sea, there is a direct transformation of vital into luminous energy. The light of the soul reacts upon the whole physical being, and is manifest in the acts, and it dispels the gloom, and the world is a cheerier and happier place because of the existence of such light-bearers.

Charles Darwin said that our forests do not shelter as many animals as do the lower forest regions of the ocean.

The fact is that during the early geological ages, the chief home of life on earth was in the sea. The waters brought forth living things before the land produced them, while the creatures of the air, the birds and the bees, came still later.

Flowering Animals in the Ocean

To be able to look in upon, and to know something of the characteristics of the dwellers on other planets, where their mode of existence must be very different from anything which we experience, would be fascinating.

The sea is a world at the antipodes of ours on the dry land, and how the creatures dwelling there exist, and what they do, is worth our effort to learn. In fact, men for centuries have been curious to know their mode of life and habits, and it is an interesting realm of knowledge in which to delve.

Until about 150 years ago it was believed that those

flowery, fringe-like things growing from stems at the bottom of the shallow sea, now known as coral, were marine plants. The Latin poet, Ovid, said that this member of the "ocean vegetable kingdom, remained soft while under water, but became hard by exposure to the air." That is an exploded theory.

If we could reach down into the sea, and touch what look so much like the petals of flowers, the animal sensitiveness would be at once exhibited. The polyp would instantly draw in its tiny tentacles.

They look so like living plants! Imagine our orange, fig or cherry trees with foliage and fruit, all alive! Think of every blossom on orange or peach tree as a living animal! and that, too, with a tiny place for retreat into the bark, when made uncomfortable by the flight of a passing bird, or the whir of a beetle.

Coral

There are numerous varieties of coral, or rather, zoöphits, which have wrought so marvelously in the sea. The coral is simply the skeleton, or hard structure, which is grown, or secreted by the tissues of these tiny marine animals. They live and work on the outer surface of the hard structure which serves as a support and place of abode.

They are the great architects in the ocean, building vast reefs and islands in the sea. No workmen in the world have ever accomplished what these toiling, pigmy creatures have done. Some structures which they have reared are a thousand miles long, by two or three hundred miles broad.

Dana says that the larger coral islands of the Pacific, at the present, are 290 in number, with a total area of 20,000 square miles; and Owen adds: "These little

world architects have built up a barrier reef along the shore of New Caledonia for a length of 400 miles, and another which runs along the northeast of Australia, 1,000 miles in extent. This represents a mass compared with which the walls of Babylon, and the Pyramids of Egypt, are but child's play. And these edifices of the Polypi have been reared in the midst of the ocean waves, and in defiance of tempest which so rapidly annihilate the strongest works constructed by man."

Coral Reefs

The coral islands are nearly always circular in form, and there is a crater-like depression in the middle. " This seems to be owing to the fact that the little workmen can support their vital energies better, where the water, being agitated, brings them a more ample supply of nourishment. The animals in the centre, being placed under different conditions, are less vigorous, and active, and consequently cannot raise their living rampart so fast."

They are very patient toilers, billions upon billions of them, far beyond our calculation, accomplishing from half an inch growth per year to two or three inches, if all the conditions are favourable to them.

It is probably not correct to term them toilers in the construction of the vast marine coral islands and reefs, which are the result of their living. Like the lilies of the field, they toil not neither do they spin. They simply live and grow and die. For them to form the coral, is no more to them than for an infant among us to grow its bones. No effort is involved in it. It simply lives, takes its food and grows its skeleton. So these " polyp-toilers," do not toil to build a skeleton,

or coral. They toil to transform the food brought to them by the ocean, and the skeleton, or coral, is the result. They transform their environment, the ocean water, and its mineral content, into that which is beautiful, jewelry fit to adorn the neck of queens. They teach us that it is a wonderful thing to live, and to grow, as the Creator intended that we should. With them, as with us, one generation succeeds another, and builds on what its predecessors have left behind, and so a valuable structure rises little by little up toward the light. It leaves its skeleton at the surface, and other agencies complete the operation.

Dana says that coral is made by organisms of four different kinds. These are: " First, Polyps, the most important of coral-making animals, the principal source of the coral reefs of the world. Second, animals related to the little Hydra of fresh waters, called Hydroids, which as Agassiz has shown, form the very common, and often large corals, called Millepores.

" Third. The lowest tribe of Mollusks, called Bryozoans, which produce delicate corals, sometimes branching moss-like.

" Fourth. Algæ, or seaweeds. They are corallitic, merely like coral. The real coral polyp is as much an animal as a cat or a dog."

The coral-making polyps vary in size from an eighth of an inch in diameter to fourteen inches. They have the ability to reproduce lost parts, and to such an extent that a mere fragment will reproduce the whole animal, very much as if one lost a leg or an arm, and immediately there could grow, not only another leg or arm, but head, body, stomach and all.

The animals are compound, many individuals being united into one colony, or polypidom, and the coral

assumes various forms, being branched, brain-like, chain-like, feather-like and so on.

Generally the coral polyps live in rather shallow water, not more than 100 or 120 feet deep, but many of the coral reefs are found which extend to a depth of two thousand or more feet, but that is owing to the fact that when the coral bearing polyps began their work in the shallow waters, the earth began to subside, and as it sank, they continued to work upward, until they arrived at the surface of the water, when they died, for they cannot live out of their native element, the water, any more than can a fish.

LeConte says: " As in the case of a tree, so in corals, life passes continuously outward and upward, leaving the middle part dead," which is really the coral, or skeleton of the animal.

There are bright red, yellow, pink and white corals, the colours depending upon the nature of the animals which created the materials.

Coral is from ninety-five to ninety-eight per cent. carbonate of lime, much like marble, but very hard, and often valuable, being used as jewelry. The finest pink coral is said to be worth from $400 to $600 an ounce.

The Scotsman in 1882 said: " The Romans believed it to possess mysterious virtues, and used to hang branches of it around their children's necks to protect them from all sorts of danger—a superstition not yet extinct in southern Italy, where coral amulets are still worn. The Hindoos wear it in their turbans, and adorn the handles of their swords and daggers with it; the rosaries of their priests are made of coral beads, and they place it on the bodies of their dead in order to protect them from evil spirits."

There is a wonderful coöperation, or division of labour, almost as if they were human intelligencies, between the polyps, madrepores, the millepores, and other coral bearing creatures, and the ocean, the storms, the birds, and many other agencies in the formation of islands and reefs in the Pacific, and other oceans.

The currents of the ocean bring the tiny creatures their food, and the carbonate of lime, and carry off the water depleted of these substances, and so aid them to live and thrive. No sooner do the little builders reach the surface of the water than they die. Then the force of the waves, lashed by the storms, breaks up the coral beds, and piles them high above the tides. Then trunks of trees, decayed leaves, and various kinds of débris are lodged in the rocky formation. Sea birds perch on it. They become, in a sense, the farmers and gardeners, dropping by accident from their bills, seeds carried from the land. After a time a stalk of corn might be seen springing up here; a wild flower there, and a weed there. And eventually an island is formed, covered with a carpet of green, with trees of various kinds; and different animals arrive, and last of all man appears on the scene.

Thus we see that there is a sublime system of adaptations in nature, whereby all the creatures on earth find their wants supplied, the coral insect, the various creatures in the sea, as well as all terrestrial animals and man. And so one has truly remarked: "It is more than probable that the human race are, like the marine creatures, working out some grand design of the great Architect of the universe, of which they have no more adequate conception than the coral worm has that it is engaged in making an island."

God has a plan for all and for each, and happy are

we if we seek to fit into it, and coöperate with Him in working out our destiny.

The Silent Deep

After witnessing a storm at sea, and hearing the roar of the breakers on the shore, we are inclined to think that the ocean is a noisy place. But it is so only on the surface.

We are accustomed to the roar of traffic in our great cities; the whir of wheels in numerous kinds of industries; the noise of vehicles; the blowing of whistles of locomotives, the sighing of the winds, the sweep of tornadoes, the roar of thunder in storms, and multitudes of other noises.

But could we descend into the depths of the ocean, where the numerous denizens of that region live and sport in their native element, we would find ourselves in a region of profound silence. Perfect stillness reigns in that solitude. Not a breath ruffles it, no tumult of vehicles, no tramping of feet in the streets, no shouts of children, no boom of waves, no roll of thunder, no sound of cataract. Such noises hold carnival on the surface of the earth, but down in the depths of the ocean, it is a temple of everlasting silence. It would be oppressive to us, who are accustomed to the din of the upper world. All kinds of creatures would glide past us, and be far above us, and around us on every side, vastly more numerous than we see living on the dry land, but not one sound would they make.

Life in the Deep

We think of the sea monsters, like the whales, and sharks, and porpoise, and all manner of great and small

fish, but these are few in number compared with the smaller creatures, which number millions upon millions. Many volumes would be necessary to recount the interesting life and history of the almost limitless multitudes of such creatures.

The first forms of life, called the Protozoa, are exceedingly numerous. They are single celled creatures, and abound in the ocean, and in fresh waters also, and are generally microscopic.

Then come the Coelentera, which were formerly called Acalephæ or Medusæ. The Acalephæ were so called because of the stinging properties of their thread-cells, from the Greek word akalephe (ἀκαλήφη), signifying a nettle. They were also called Medusæ because of their long trailing threads hanging from their pulpy saucer-like disks, recalling the coil of poisonous snakes in the fabled Medusa's hair.

We generally know them as the jelly-fish seen on the shore of the ocean, shaped somewhat like an inverted saucer, with threads trailing beneath the creature. They vary in size from a mere speck of jelly, to a yard in diameter.

The long thread-like processes, and in fact the whole animal, has the power of imparting an exceedingly poisonous substance which surpasses anything of the kind possessed by the bee. The bee has only one sting, while in the Medusæ they may be reckoned by the myriads.

The poison threads do not depend for action on the will of the creature to which they belong. If a single filament be separated, and be washed against the human skin, it will sting with as much virulence as if it were attached to the body whence it sprung, and which may be miles away. Sometimes persons bath-

ing in a swimming pool are stung by one of these filaments which has come into the pool through the supply pipe.

Dutertre says: "One day when sailing at sea in a small boat, I perceived one of these little 'galleys,' and was curious to see the form of the animal; but I had scarcely seized it, when all its fibres seemed to clasp my hand, covering it as with bird-lime; and scarcely had I felt it in all its freshness (for it was very cold to the touch) when it seemed as if I had plunged my arm up to the shoulder in a caldron of boiling water. This was accompanied with a pain so strange, that it was only with a violent effort I could restrain myself from crying out loud."

In some parts of the ocean their numbers seem incredible. The navigator Scoresby mentions that in sailing over the sea in the region of Greenland, he discovered an enormous colony of them, 20,000 square miles in extent. It was one of the main feeding grounds of the whale, which gulps them down by myriads.

By an arithmetical calculation he ventures an estimate of the number of such jelly-fish in each square mile as twenty-three quadrillion, 888 trillion; and in the 20,000 square miles there would be 238 quintillion, 880 quadrillion, and this was only a fragmentary part of the ocean.

These creatures, while constituting food for other animals, obtain their food from the ocean, and feed largely upon others. These apathetic murderers easily make victims of Crustaceans, worms, and even of fishes themselves, in spite of their swiftness, activity and strength. They are firmly seized by the transparent filaments and disk of the medusæ, and slowly forced

into the creature's stomach, where they are speedily dissolved and melted away, their solid substance disappearing in the soft, transparent body of the jelly-fish.

The stinging power of the creature is undoubtedly employed in catching its prey. The stinging property is due to the presence of an acrid fluid which exudes from the whole surface of the creature's body, so caustic in its nature, as to cause great irritation. This pungent fluid seems to torpify and palsy all the faculties of its prey, which lie quite paralyzed and motionless, wrapped in the venomed folds of its destroyer, and at length is swallowed unresistingly.

Among men we have seen what appeared to be an invisible foe attack and destroy a strong, intelligent person. The poison sting of sin touched his soul; the first experience of which was painful. But the repetition of it produced an apathy, a deadness and indifference to the danger. Presently the victim, without resisting, was wrapped about with the evil, which at first had been painful, but now was unnoticed, and from then on by easy, painless stages his debasement and ruin became complete.

There is another and brighter side to the picture presented by these jelly-fish. According to T. Raymer Jones, a writer on the "Natural History of Animals," these Cœlenterates not only serve as food to the countless animals, but possibly the sea itself is fitted by their agency to be the residence of beings that would otherwise perish. It exudes large quantities of mucus, or thick slime, which mixes with the surrounding waters. This material is so copious, that if a specimen be placed alive in a large vessel filled with water, in a little time the whole is rendered thick and

viscid, so that the creature would perish speedily from the accumulation of its own secretions. This continues as long as life lasts. This viscid matter exuded by the countless Cœlenterates, inhabiting every part of the ocean, must cause important changes in the water around them, "filling it with animal substance upon which innumerable races may be fed, a kind of nutriment adapted to the feeble mouths of new-hatched spawn, or ocean's tenderest progeny. Thus in the mighty scheme of Nature every race is made subservient to the general good, silently working, and too often alas! unseen, unnoticed, and unknown, though showering blessings over half the world."

These are among the self-luminous creatures to which we have already referred. These stars of the ocean have been sown lavishly in microscopic myriads, a living Milky Way. "Partly from their small size, but more from their extreme transparency, they escape observation by daytime, nor can they be seen even by the microscope, so perfectly translucent are their bodies; but as the night reveals the stars of the heavens, so does the darkness bring to light these living luminaries, else invisible, contrasting, as it were, with those above, and silently repeating the great truths they tell."

"To Him, no high, no low, no great, no small;
He fills, He bounds, connects, and equals all."

It is estimated that at least thirty or forty thousand of these sparkling beauties of the sea must exist in every cubic foot of the sea water, and so we exclaim with an old writer, "Surely if the sky has stars, so has the sea likewise!"

A Single Drop of Sea Water

What a wonderful thing is a drop of water, and a drop of sea water is more wonderful still! Each one is composed of molecules, and each molecule is made up of atoms, and each atom of electrons, protons and photons; and each proton, electron and photon is a whirl of something, probably the ether.

In forming water we do not know definitely which of the atoms do the coquetting, and which the proposing and seizing; whether the two atoms of hydrogen seize hold of the one atom of oxygen, in which case we have polyandry, or the oxygen atom appropriates the two hydrogen atoms, and we have polygamy. At any rate, as the result of the union of these three, we have one molecule of pure water.

It is a fine, important family, and surely enough for both husband and wives to look after; for they have been espoused before, and each Mrs. Hydrogen had three children, the little electron tribe, named respectively, proton, or stay-at-home, electron, or whirl-about, and photon, or toiler. Mr. Oxygen had all told twenty-four children, eight protons, eight electrons, and eight photons, or toilers, and so the new arrangement after the wedding, made them a good sized household of thirty members.

But sea water has something more. There has crept into that family, composed of three atoms, many more. The latter come and go, like so many tramp-tenants, sometimes many of them, and again they crowd in with lesser numbers. For instance, a drop of pure water falls from the sky into the ocean, and instantly some of the molecule-boarders, temporarily dwelling in the water next door, rush toward the new

molecule, and take up their abode within it, where there is more room.

In dashes a molecule of Sodium Chloride, which is composed of two atoms, one of sodium with an atom of Chlorin hanging around its neck. The two make a fair sized family in themselves for the atom of sodium has fifty-one children, seventeen protons, seventeen electrons and seventeen photons, and the chlorin atom has in her brood fifty-four, eighteen protons, eighteen electrons and eighteen photons. These had no sooner attached themselves to the dwelling of the water-molecule, than in walks a distant relative of the aforesaid tenant, a molecule of Chloride of Magnesium. This too had quite a progeny having two atoms of Chlorin, each one of which had fifty-four in her family, or 108 all told, eighteen protons, eighteen electrons and eighteen photons in each atom; and the one atom of magnesium having twelve protons, twelve electrons and twelve photons.

The molecule of water had barely time to say, "How do you do?" when a rap was heard at the door, and in comes another straggler in the form of a molecule of Chloride of Potassium, a distant cousin of the one that had just preceded her. Here too was a family having an atom of Chlorin with fifty-four inmates, and an atom of Potassium containing nineteen protons, nineteen electrons and nineteen photons, or toilers.

These had barely settled into bed, when in walked another stranger, a molecule of Calcium Sulphide, having one atom of Calcium, one of Sulphur and four of Oxygen. The Calcium atom had sixty children, twenty protons, twenty electrons and twenty photons, and the Sulphur atom had quite a family, forty-eight

in all, sixteen protons, sixteen electrons and sixteen photons, and the four Oxygen atoms each had a family of twenty-four, or ninety-six in all.

By this time the little house of the water-molecule was pretty crowded, but a knock was heard at the door, and in strolled another family, in a molecule of Sulphate of Magnesium, having one atom of Magnesium, one of Sulphur, and again four of Oxygen, making all told, seventy-five in the Magnesium atom, forty-eight in the Sulphur atom, and ninety-six more of the Oxygen tribe, 215 crowding in all at once.

And as if that were not enough for our molecule of water to lodge, a molecule of Bromide of Sodium came trooping in, having hanging to her skirts, an atom of Sodium and one of Chlorin; the Sodium having thirty-three children, and the Bromine 105.

We can only imagine how crowded the little domicile of the molecule of water was in having twenty-one hobo-families with their 917 children come crowding into it.

From that time on there was no rest for the thirty water babies. There was always something going on, mostly dancing, in which the thirty stepbrothers and stepsisters joined, making 950, all waltzing about in their water-Virginia reel.

This attracted the attention of the neighbours; for the Phosphoric Acid family came, consisting of seven adults, two of Hydrogen, four Oxygen and one Phosphorus atoms. Mr. Phosphorus was a polygamist, for he had six wives. The total children of that family numbered 145, Phosphorus forty-five, Hydrogen three, and ninety-six in the four Oxygens. They all came perambulating over to the water-molecule household, and peeped in at the window, to see what was going

on; and also there ambled over another family, the Carbonate of Lime one, with their five adults, one Calcium atom with her sixty children; one Carbon with eighteen children; and three Oxygen atoms with seventy-two, making a total of 155, five adults, and 150 children. They caught hold of the casings, and looked in at the windows.

A Dizzy Dance

And as if there were not enough commotion already, up came a host of other parents, and their children, and clung fast to the sides of the water-molecule dwelling. They were as follows: The Iodine family with 159 children; the Fluorin family with twenty-seven, the Silicon with forty-two, the Carbonate of Magnesium with five adults and ninety-six children, the Silver family with 141 offspring, the Gold family with 237, the Lead with 246, the Copper with eighty-seven, the Arsenics with ninety-nine, the Nitrogens twenty-one, the Argons fifty-four, the Carbon Dioxides, three adults and sixty-six children, the Neons with thirty children, the Kryptons with 108 offspring and the Xenon with 162.

This made a total of 1,803 adults and children which came, and clung to the outside of the water-molecule home, interested in the dance of the 950 inmates. Soon they started a waltz of their own on the outside. All the molecule families swung their brood into a wild, dizzy dance, zigzagging as they went, having six billion encounters each second, and traveling about a mile a second, while their baby electrons, being more nimble, danced about their proton sisters six quadrillion times a second, also going more than 180,000 miles a second, while the photons held up their hands,

and also further sustained them by flashing light upon their path.

What a picture the water-molecule home now presented, with 2,753, all joining in the whirligig dance. When the group sank deeper into the sea, where it was cooler, the dance slowed down, and they acted weary. But as it rose to the surface, and came into contact with the warm rays of the sun, the dance became more lively, and they were in a frenzy of excitement; they spread out from one another further and further, still holding hands, while the dance increased with the heat.

Resolved to Escape

As the inmates of the water-molecule home spread further away from one another, an idea dawned upon the family, and the Mistresses Hydrogen said to their husband, Mr. Oxygen, "Now is the time to shake off these hobos who have been hanging on to us. We feel as light as air. We'll leave this briny deep, and although you are not so light as we, if you cling to us, we will lift you out of this motley crowd."

It was agreed to, and soon the home expanded enormously, many hundreds of times, and up went the two Hydrogens, and Mr. Oxygen clung to them, and off dropped one after another of the tramp tenants, back into the sea, to find new homes, while the pure water-molecule mounted up to the sky, as happy as could be to be free once more; and joining others of a like disposition, they floated together off toward the land where men were praying that water might come and refresh their crops, and save them from utter destruction, in the long continued drought.

And so our water-molecule family carried blessing in its heart to the needy; plants were revived; thirsty

babies were refreshed; wells were filled; rivers and streams flowed more freely, and the wheels of commerce revolved more smoothly, and ten thousand things were better, all because the water-molecules had returned from the sea.

But what about those others which were left in the sea? What were they doing? I wish we could see them as they are, but if so, I am inclined to believe that it would be such a sight that we would never dare to ride again in a boat on the trackless deep, and that it would agitate our brain to such an extent that we could not get the sight out of mind for a month.

Consider. If a single molecule of sea water consists of over 2,750 whirling, dancing, zigzagging bodies, what would a whole drop be? Why, there are so many molecules in a single drop, that if they were enlarged so that we could see them, or better, if they were increased to the size of large peas, and the drop itself were correspondingly enlarged, it would be as large as the earth, 8,000 miles in diameter. How many molecules are there in a drop of water? As many as you could drop peas into this earth, if it were a hollow sphere.

Again. How many drops are there in the ocean? They are all composed of our dancing, whirling, zigzagging molecules, moving freely among one another, and as soft to lie upon as a downy pillow, and yet, when driven by the wind, as hard as steel. And down among these dancing bodies, move freely the creatures which God has placed there, and all draw their life from that mighty, mysterious element, which feeds and protects them, and at the same time is the source of life and refreshment to all the inhabitants of the earth. Oh, the wonders of the sea!

Questions for Review

1. How many square miles of the earth's surface are covered by the sea?
2. How does a stormy voyage enlarge one's conceptions of the sea?
3. What Psalm gives, in brief, an accurate account of a storm at sea?
4. What per cent. of animal bodies is composed of water?
5. How does heat affect the molecules of water?
6. When does evaporation occur? What becomes of the vapour?
7. What must molecules of vapour meet with to enable them to form drops of water?
8. Why is it important that the sea is so extensive?
9. How were the sea basins, depressions, formed?
10. What is the chief source of moisture on earth?
11. What in the sea makes it a purifier of the earth?
12. Give the percentage of the various salts in the sea.
13. What is the source of the salts and minerals in sea water?
14. Are all parts of the sea equally salty? Why the difference?
15. How large an area would the salt of the sea cover, and how deep?
16. What causes the currents of the sea? Name them.
17. How does the temperature vary between the surface waters and those deeper down?
18. What rate of movement has the earth at the equator? At the poles? In latitude 45°?
19. Where does the Gulf Stream begin? What as to its size?
20. How does the temperature of the water vary in the Gulf Stream?
21. What current from the north meets it?

22. How does this affect the Gulf Stream? Where do they meet?

23. Trace the course and give the terminus of the Gulf Stream.

24. How do such ocean rivers affect navigation? And icebergs?

25. Give Captain Duncan's description of icebergs.

26. How do surface currents affect our lives?

27. What causes tides?

28. Why are they higher in some places than in others? Give examples.

29. What benefit to the earth and man are tides?

30. How do they manifest Divine wisdom?

31. Give some description of the seascape.

32. What of mountains, rivers, valleys, and plains in the seascape? With what on land do the blank spaces correspond?

33. Give some description of the forests and vegetation of the sea.

34. How do land forests differ from those in the sea?

35. How many different kinds of fish are there? Of crustacea?

36. What is the ooze? What does it form, and how?

37. What are the zones of the sea? With what do they correspond in buildings? Name the zones.

38. What about solar rays in the lowest zone?

39. How far down in the sea can animals live?

40. How does the absence of light affect animal and vegetable life in the depths of the sea?

41. Among animals what is the conformity of colour to environment called?

42. Describe some of the beauties in the depths of the sea.

43. Describe some of the ocean flower gardens.

44. Name the Author of all beauty. What are the purposes of such beauty?

45. Describe some of the sea beauties as mentioned by Schleiden.

46. What about life in the ocean depths?

47. How deep down does vegetation generally grow? Is this so of animals?

48. What about adaptation to environment?

49. What of life struggles in the sea?

50. How is life in the sea in contrast with ours?

51. What of the phosphorescence of the sea? What causes it?

52. What do Doctors Carpenter and Darwin say of this light? What does Canon Bateman say concerning it?

53. What are "living lamps" of the sea? How does this light differ from that of phosphorescing minerals?

54. Have men been known to shine? When and why?

55. What of the flowers of the sea? What are they?

56. What is coral? What causes it? What of the coral islands in the Pacific? How many, and what their size? What are coral reefs? What as to the time required to build these?

57. Are coral-polyps really toilers when they build reefs? What do they teach us? How many organisms form coral? What are they?

58. At what depths do coral-polyps live?

59. Of what is coral composed? Why is it often so highly prized?

60. What lessons, as to coöperation, do we learn from these creatures? What of adaptation in nature?

61. What of the silent deep?

62. How do the great animals compare in numbers with the smaller ones? Describe some of the numerous smaller ones.

63. What of the jelly-fish? Describe them, and some of their habits. Give illustrations.

64. What as to the numbers of such creatures? What use is made of their stinging powers by jelly-fish? What causes the sting?

65. What suggestions does this offer to us in our human relations?

66. What as to the transparency of the self-luminous sea creatures? How numerous are they?

67. Describe a single drop of sea water. Name its contents. How many members in that family? What causes a disruption? Illustrate.

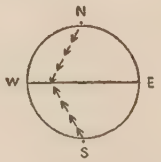
V

SNOW

SNOW being a solid form of water, it is, like that element, an essential in our physical existence and well-being.

In vast regions of the earth snow is never seen, and the dwellers there generally feel that they are fortunate in not having any contact with it. They think of those living in high mountainous regions, and in the extreme temperate and frigid zones, as enduring great hardships, and oftentimes many of them do, but if there were no snow anywhere, this would be a very different world, and the winds and climate would be so greatly changed from what they are at present that it is doubtful if men could exist on it, certainly not with the variety and comfort which they now enjoy.

Because of the rotation of the earth from west to east, there is a movement of the earth at the equator of about 1,000 miles an hour, and this speed steadily diminishes in all latitudes toward the poles, where it is at a minimum, or nearly stationary. This motion tends to cause the winds to blow from the east to the northwest in the northern hemisphere, and from the east toward the southwest in the southern hemisphere, as will be seen from the diagram below:



But the configuration of the continents, the snow capped mountains, and the snow and ice at the poles, greatly modify these trade winds of the Atlantic and Pacific oceans, and the monsoons of the Indian seas.

The cold atmosphere in the snowy regions, being more dense than the heated, and not so rarefied, the air, as we approach the equator, rushes in to fill the place of the ascending currents in the heated regions. This imparts a variability to the air currents which tends to counteract the monotony of the steady movements of the atmosphere, and at the same time to carry moisture to the land surface, and thus to produce general fertility and refreshment for the well-being of both vegetable and animal life.

But when the secrets of snow are searched into, it is found also to minister to our mental, ethical and religious natures, as well as constituting an important link in the chain which Nature has forged to bind all the elements of the earth into one whole, so as to make this a good world in which to live.

Some very searching, and thought-provoking questions were propounded by the Lord to Job, in the 38th chapter of the book of Job, and among them was this: "Hast thou entered into the treasures of the snow?" Let us seek out some of those treasures.

Two Kinds of Beauty

There are some works of art which have their beauty enhanced by distance. They will not bear close inspection. There are others which are wrought in minutest detail, and in strict adherence to the truth. Your magnified inspection reveals no defects, no slighted portions.

If this be true of the productions of man, it is par-

ticularly so of those of God. Beauty is manifest everywhere. The mountains and valleys, the hills and plains reflect the light in variegated colours. The autumnal forests are liveried in green and purple and gold. The clouds at sunset are surpassingly beautiful. Delicately tinted and gorgeous flowers nod in the breezes, as if to express their thanks to the Creator for arraying them in colours more beautiful than was Solomon in all his glory.

Close inspection does not destroy the beauty of these works of art. Dissect a flower. Tear asunder the petals, and new beauties appear, as you go deeply into its structure. Multiply your visual powers a thousand fold by the microscope, and then you discover that the dust on the wing of a butterfly, or of a moth, is as carefully constructed in the minutest detail, as though it had been made for an angel; and that each of the 4,000 lenses in the eye of the common fly is as perfectly constructed as is the crystalline lens in the human eye. To behold the wonders of the works of God, we need to look at them in detail, as well as a whole.

God's Thought is Seen in the Snow

Applying what we have said above, we shall see that God's mind is mirrored in the snow. Snow is crystallized water. Even a superficial examination of its particles will reveal to one that it is much more than drops of water frozen into whiteness, in haphazard indifference as to the forms assumed.

Each snowflake which falls in a shower, is constructed on mathematical principles as exact as the most complicated geometrical figures.

If one wishes to investigate for himself, he can

catch the flakes on a cold mirror, or a bit of window glass, and view them with a magnifying glass. He will discover varieties even in a single fall of snow, sometimes thirty or more, but all are constructed on the plan of a six-rayed star.

Being six rays, the angle of the snow-star is of necessity 60°, since six angles are constructed out of the 360 degrees of the entire circle.

Although a thousand varieties of snow-stars have been distinguished, yet the same form is ever adhered to. Think of the marvelous ingenuity displayed in forming a thousand varieties of snow-flowers with a six-rayed star as a basis!

There is a scientific explanation as to why the molecules of water, when they congeal into ice to form snow, will arrange themselves into such orderly forms as they are found to be in, when examining snow under a magnifying lens. But the scientific explanation of a thing does in no wise do away with the wonder and mystery of it.

When a bar of iron is magnetized, one end will have a positive pole and the other a negative pole, and the centre will be neutral. Cut the bar in two, and still each end will have its positive and negative poles. Continue to cut it in two, and the same thing will be true, and when you come at last to the single molecule, it too will have its positive and negative poles.

And it is known that like poles always repel, and unlike attract one another, and the same is true of the atoms in a molecule.

Just at the time when water is about to congeal into ice, or snow, it expands, and the molecules are thus afforded more freedom to arrange themselves according to their polarity; and with water, composed of a

combination of two atoms of hydrogen and one of oxygen, this is always at an angle of 60°, and hence forms according to the pattern of a six-rayed star.

Undoubtedly the number of electrons within the atoms of hydrogen and oxygen determine the shape assumed when the molecules are left free to form themselves in accordance with their respective degrees of attraction and repulsion.

Atoms of matter, consisting of revolving electrons, protons and photons, are like so many gyroscopes, always speeding at a definite rate, and when such atoms form molecules, the same is true within the molecules.

And the number and relative attraction and repulsion of the atoms, and also of the electrons within the atoms, which form the molecules of water, being always uniform, the crystallization formed by the molecules of congealing water, will always assume definite forms; and in molecules formed of two atoms of hydrogen and one of oxygen, as in water, the position assumed on freezing is uniformly along the angle of sixty degrees, and this, and other attractions and repulsions more or less diverse on the molecules, result in forming a six-rayed star, with thousand-fold variations.

There is marvelous building power brought into play during the formation and descent of a snow-shower. As the temperature in the clouds sinks to freezing, or thirty-two degrees, the molecules of vapour begin to expand, and before congealing, each waltzes forth into a certain definite relation to its neighbour, like poles repelling, and unlike attracting one another. As their rhythmic motions slow down somewhat, they settle into myriads of roseate flowers, but always on the model of a six-rayed star.

One could search over the snow fields of the world,

and he would never be able to discover a single natural flake with four, five, seven or eight rays, but always six. Such invariable uniformity, commingled with millennial variety, can be no accident.

And hence we conclude that there is wonderful intelligence displayed in these tiny fallen stars. We can trace the genealogy of the snow to the overhanging cloud, and from the cloud to the invisible vapour of the atmosphere, and from the atmosphere to the bosom of the ocean, and from the ocean to the expanding and lifting heat of the sun, and from the sun to the Creator. And in every step of its onward march, the might and mind of God are manifest.

Hidden Power in Snow

The Creator's power is manifest in the snow. In every fall of snow His power is as really manifest as it was in sending the manna each morning to the Israelites.

In sundering the molecules of vapour, and building them into flakes of snow, there is the expenditure of tremendous force. A learned writer maintains that to produce from water a quantity of snowflakes which a child could carry, would demand an energy competent to gather up the shattered fragments of the largest avalanche of the Alps, and hurl them into the air twice the height from whence they came. If a single baby-handful requires such force, what power must be put forth in a snow storm which often blankets a large area of the earth a foot or two deep?

Great danger may lurk in this snow power. The insignificant dust of icicles, the broken rays of stars celestial, commingled in their magnificent ruins, the easy wrecks of winds which dash them upon one

another, is most terrible to human life. You toss this shattered star dust into the air with your hand, so harmless it seems, but broken and driven by the wind, they penetrate the smallest opening, force their way between the closely woven threads of clothing, and through the seams of fur garments, enter the pores of the skin, invade the lungs, and originate painful and dangerous diseases. Aware of the dangers they encounter by such storms, the dwellers in arctic regions never expose themselves in violent storms.

A friend who spent some winters in North Dakota witnessed several blizzards. He said that he dare not, in such a storm, trust himself to go from the house to the barn to care for the horse, although it was but a short distance, without fastening a rope to the house, so that if he became bewildered and blinded by the storm, he could hold on to the rope, and by its aid be able to find the house. No one was safe if he were caught away from home in such a storm. He had known of large quantities of snow to be piled into a room, almost filled as he expressed it, by being blown through a keyhole.

Note the silent work of snow contrasted with the noise of men. The temperature falls a few degrees, and the army comes. A hush falls upon the roar of traffic, and the noise of wheels. The temperature rises, the storm ceases, and men with snow-plow, clank of shovel and jostle of trucks, begin the task of removal, but a balmy breath is breathed out of the south, the sun unveils his face, and the Creator's army melts away as silently as it came.

Snow on the Mountains

The power of snow is most marked on the moun-

tains. While sleeping one night with a party of Alpine climbers, on the Grünnhorn peak ten thousand feet above the sea, we experienced the awe-inspiring effects of an avalanche. The snow had accumulated in a mighty mass upon a peak hundreds of feet above our heads, but a little to one side. The last ounce had been added to its weight, and there it crouched as a mighty monster waiting for its prey. Suddenly we were startled by its appalling roar, as it came tearing down the mountain side, rending the rocks from their base, and filling the gorge below us with its reverberations, as if the earth itself were being rent asunder.

Avalanches often fall with such resistless force that they crush old forests, as if they were but reeds, and wrench mighty rocks from their base. The very wind which they produce levels trees and houses to the ground.

Delicately balanced masses of snow and ice lie upon the mountains, and the slightest weight will loosen them. The mass is in a state of equilibrium, and the most delicate waves which are in unison with their vibratory rate, may be sufficient to start the mass down the mountain side. And hence mountain climbers are always cautious about firing a gun, or shouting, or making any unnecessary noise, for fear of starting an avalanche.

This is well brought out by Rogers in his couplet regarding the chamois hunters:

"From rock to rock high on their iron poles they pass,
Mute lest the air convulsed with sound,
Rend from above the frozen mass."

March 1st, 1864, Brennen, a famous Alpine guide,

lost his life in an avalanche, which he and his companions started, on the Haut de Cry. He allowed himself to be persuaded to attempt the ascent at an unsafe season. The party sank into soft snow on the slope of the mountain with the summit in full view. Suddenly they heard a report above them resembling a pistol shot. It was the crack of the snow. Brennen tossed his arms into the air and solemnly exclaimed: " Wir sind alle verlorn " (we are all lost). The fatal rush followed in a moment, and the noble guide, and a Russian gentleman to whom he was roped, were dug, dead, out of the snow several days afterwards.

The Beauty of God in the Snow

We also behold the beauty of God in the snow. With this, as with almost all the works of nature, beauty and power go hand in hand.

We have already referred to the fact that when snowflakes are seen magnified, they have the appearance of regular geometrical figures, systematically arranged around a centre, with a six-rayed star as a pattern. There are snow stars of every variety of shape. One will resemble a flower with six petals, another, a hexagonal star cut with the most exquisite delicacy, and still another a graceful arabesque.

They are the flowers of inorganic nature, and presage the blossoms which spring will presently usher in. " They look as if their translucent spiritual beauty needed only the Promethean fire to glow into the rosy life of June."

Little do we realize that when we walk upon the snow, we are treading under our feet a veritable garden of beautiful flowers, and that every one of the myriad of myriads which cover the earth, is fashioned with

as much care and beauty as if expressly designed for critical inspection.

And when we place under the microscope the poorest and meanest of refuse produced by nature, which we are loath to grace with the touch of our foot, we see it unfold into a marvel of beauties. And then when we consider that such loveliness is stamped upon everything, animate and inanimate, with which we are surrounded in creation, we are irresistibly forced to conclude that all these but mirror the beauty of the mind of the Creator.

God's Goodness Seen in Snow

Compared with its bulk, snow is extremely light. In the main it consists of innumerable little spicules of ice, interlaced together, and having a great quantity of air enclosed in the meshes, and hence its lightness, compared with water.

Snow protects the ground from intense cold because of this interlacing mass of spicules with air enclosed in the meshes. Were it not for this blanket of ice and air, which snow is, all vegetation in the Arctic regions would perish, and much of it in warmer regions.

It has been found that when the temperature registered thirty degrees below zero, Fahr., the temperature under two feet of snow was twenty-two degrees warmer, and at four feet it was two degrees above, and at eight feet it was twenty-six degrees above, a difference of fifty-six degrees. This difference is due to the fact that the air entangled in the icy particles, which snow forms, renders the mass a poor conductor of heat, so that the ground is able to preserve its warmer temperature as we have seen.

Were it not for the snow, a large part of the United

States would be worthless, or nearly so, for agricultural and fruit raising purposes.

It is the air which is entangled among the hairs of fur, and the barbs and barbules of feathers, that makes such coverings so bad as conductors of heat that the animals clothed by them, " are enabled to a large extent to defy the winter's cold."

Without the perpetual snow upon the mountains, which acts as a condenser, a vast portion of the earth now fertile, would be rendered a lifeless and desolate waste. These cold sentinels chill the moist atmosphere, and produce rainfalls, which issue from the high altitudes as springs, and augmented by others, become rivers, and thread their way to the sea, turning the wheels of commerce, and performing the work of irrigation. Other chilled moisture falls as snow, forms glaciers, and performs these beneficial functions.

The soil of the earth, now occupied and cultivated by man, was largely made by the same processes which are now in operation through the action of snow in the mountainous regions. And hence it is true, that just as each season we owe the bloom and brightness of our summer to the snowy blight of winter, so do we owe our present summer beauty of the world, to the great secular winter of the glacial period, which formed our productive plains out of the ruins of the mountains, ground and washed down to the lower levels.

Why Snow Is White

As out of white light, all the colours of the rainbow spring, and to it they return, so all the variegated colours of summer are gathered up into the pure white of the snow.

Why is snow white? Where the whole of the sunlight falling upon a body is reflected, it produces in us the sensation of whiteness.

The minute spicules of snow are perfectly transparent. They allow nearly all the light falling upon them to pass through. But when the light at the edges of the spicules meets the air, which is a medium of less density, some of it is reflected, and these reflected rays are not of any one colour, but of all colours, which we know is white light.

As light passes through snow, it is constantly changing from the medium of the density of ice to one of the density of air. Each tiny spicule which the light passes through, reflects some of it at its edges, and the light does not go very far through snow, until all of it has been reflected, and so produces in us the sensation of whiteness.

And hence the strange thing about snow is that though it is composed of transparent particles, and is perfectly white, it is at the same time, as a whole, absolutely opaque.

And this is also true of many other things. Glass is transparent, and yet when broken into bits, you have a white opaque powder. Each tiny bit of glass is still transparent, but the powdered glass as a whole is opaque.

The same is true of pure water, which is transparent, but lashed into a foam, it is white and opaque. That is the reason why the breakers on bodies of water are "white caps," as we term them. They are white, but you cannot see through them.

Each particle of watery vapour in steam is transparent, and yet the steam as a whole is white, as we see it pour out of the funnels of steam engines, but it

casts a shadow, as truly as do the white fleecy clouds, whose shadows race over the earth.

The constant and numerous reflections of the light, as it passes through snow, pulverized glass, breakers or " white caps " on bodies of water, or vapour particles in steam, render these things opaque to us, and yet they are all white, for they transmit to us the whole of each beam of white light without breaking it up into any of the seven primary colours of which white light is composed.

Snow Is a Type of Purity

God's purity is symbolized in the snow. What seems purer than the immaculate of white, covering the earth! We all know that water purifies itself from stagnation by motion, but in the snow, we see water purifying itself by rest.

One year before His death, Jesus retired with three of His disciples to one of the horns of Mt. Hermon, and was there transfigured before them. Each of the Gospels recounts His white and dazzling appearance. Matthew says: " His face did shine as the sun, and his raiment was white as the light."

Later, when John was on the island of Patmos, he beheld a vision of Jesus walking in the midst of the candlesticks, and he declared: " His head, and his hair, was as white as white wool, white as snow. His eyes were as a flame of fire; and his feet like unto a stream of molten metal as it had been glowing in a furnace, and his countenance as the sun shineth in his strength." These outward appearances, as well as the beautiful works which have sprung from His creative hand, are but the reflection of His inward purity of character.

The Higher Lessons from Snow

We have seen that God's mind is mirrored, His power perceived, His beauty beheld, His purity presented and His mercy manifested in the snow. Shall such treasures be in the fragile, fleeting snow, and not also be in us His highest creatures?

The universe which Christ brought into existence by His creative power, prefigures the new and more wonderful spiritual creation which He ushered into existence by His sacrifice on the cross for us. And His constant creative energy manifest in the operations of nature, typifies the continuous work of His Spirit in our hearts, energizing and sustaining His spiritual creation within us.

The work of Christ's spiritual creation is as truly a continuous process as His older creation in nature, and like the latter, it needs and receives His constant life-giving and moulding presence and power.

The moment the heart receives Him, it becomes a part of that new creation, but by that very fact, it also becomes the theatre of Christ, in which He works out His honour before men and angels.

He purposes to show His mind and might in the hearts and lives of those who trust Him, that others beholding, feel like saying: "These are surely the manifestation of the love of God; for such lives cannot be the product of the laws of heredity." That which He wrought in the unpromising lives of His first disciples, He wishes to repeat in every life, so that those beholding shall take knowledge that he has been associating with Christ.

The beauty which He has stamped upon nature, is but the type of that higher spiritual beauty which He

imparts to the heart of each one of His children. There can no more be beauty of character apart from Him, than there could be beauty in nature without His presence. Pandemonium would reign instead of law. All would be chance. The fitful uncertainty, and discords in many lives, are due to a lack of keeping in tune with Him.

He desires His purity reflected within, and through us. By His presence, He would impart to us a pure heart, a pure mind, a pure body, issuing in purity of thought, purity of speech and purity of habits.

But the crown of all His manifestations in nature, and in us, is His mercy; His boundless love. The first streaks of the day dawn of His love we see in His merciful provisions in the snow, and other works of nature, but in His death, we behold the full noon-tide glory of that day; and now He wants the full day of His love to shine into our hearts, dispelling our darkness, and making us like Himself.

Love is to be the motive power, the foundation and crown of our life, as it is of His, who is manifest in the fleeting snow.

Questions for Review

1. How are those living in snowless climates inclined to feel regarding those dwelling in snowy regions?
2. In which direction does the revolution of the earth on its axis cause a motion of the earth?
3. How does this motion affect the atmosphere?
4. What tendency does this impart to the winds in the northern hemisphere? In the southern?
5. How does the cold atmosphere of the poles, and of the snow-capped mountains effect changes in the currents of the air?

6. How do these changes affect the general living conditions of the earth for the welfare of man?

7. How are some kinds of beauty affected by distance? How, others by close inspection?

8. What of the presence of beauty in nature?

9. How does the beauty of nature appear when viewed through a microscope? Give examples.

10. How does this apply to snow?

11. On what principles, geometrically, are snowflakes formed? How can one observe this for himself?

12. How many rays in every snowflake star? On what angle are these rays always arranged?

13. Is there any explanation of how such snow stars are formed? Does this explain why they are thus formed?

14. Illustrate by an iron bar and filings.

15. When water is congealing into ice what occurs?

16. Why is there always this uniformity in the formation of snow stars? How many varieties of snow stars are there?

17. Trace the genealogy of a snowflake.

18. Give an illustration of the power expended in the production of snow.

19. Give examples of how snow may become a source of great danger. What as to snow blizzards? Also, the silence of the snow-army in contrast with man's noises?

20. What as to the snow on mountains? Mention the force of avalanches.

21. Why are chamois hunters silent when passing over mountain snow and ice? Give Rogers' stanza.

22. Why is it particularly dangerous in certain seasons to ascend high mountains? Give an example.

23. Mention some of the varieties of snowflakes.

24. How is the Creator's love of beauty seen in snow?

25. What is stated regarding the weight of snow?

26. How does snow protect vegetation?

27. Give some examples of the varying degrees of temperature under snow and on the surface.

28. Why is snow a poor conductor of heat?

29. What benefit to the earth is snow on the mountains? Why is this?

30. What had snow on the mountains to do with the fertility of the earth? What is that age called?

31. Why is snow white? Give the reasons.

32. Is snow, as a whole, transparent or opaque? Why is this? Give an illustration.

33. Are the particles, or molecules, of watery vapour transparent or opaque? What of steam, as a whole? Of powdered glass?

34. What causes snow and powered glass to appear opaque to us?

35. How is water kept from stagnation? How is snow purified?

36. What was Jesus' appearance when He was transfigured on Mt. Hermon? How did He look when John saw Him later on the island of Patmos? Whence are the beauty and glory which are seen in nature?

37. What does this physical universe prefigure?

38. Has the work of creation ceased?

39. Of what is the beauty of nature a type? Name the source of all beauty, physical and spiritual.

40. What is the crown of all God's attributes? What does He desire should be the motive power of our lives?

VI

STONES THAT TALK

ROCKS are the original source of all soil. And so it is that, through intricate transformations, stones have provided us with a body, and continue to nourish it. They also speak to us.

Jesus was having shown to Him the first and only public welcome which was accorded Him while on earth. He was riding an unbroken colt from the village of Bethphage and Bethany on the eastern slope of the Mount of Olives, up over the mountain to Jerusalem.

To the people, His riding thus, was a sign that He was about to be crowned king in Jerusalem. Horses were for war, but to ride upon a mule, as in the days when David caused Solomon to ride upon the king's mule to indicate that he was to assume royal prerogatives, meant that Jesus was to become their long expected king.

The enthusiasm of the common people broke over all the bounds of propriety, particularly in the minds of the envious Pharisees who hated Jesus, and were so soon to compass His death. Why should this meek man permit such royal honours to be accorded to Him by the populace, who were only rabble in the minds of these religious rulers?

The garments strewn in the way for Him to walk over, the waving of the palms, and the glad shouts of the people were indicative of some folly which might be perpetrated in Jerusalem, if this unseemly ado over

this usurper of the autocracy of the Pharisees were permitted to go on, and so, with no small degree of petulance, some of them mingling with the multitudes, cried out: "Master, rebuke thy disciples!" Jesus replied: "I tell you, if these should hold their peace the stones would immediately cry out."

Stones Really Cry Out

This is not a mere figure of speech. It is the statement of a fact. The prophet Zechariah, several centuries before, had been accorded a vision of this event, and he had exclaimed: "Rejoice greatly, O daughter of Zion; shout, O daughter of Jerusalem; behold thy King cometh unto thee; he is just, and having salvation; lowly, and riding upon an ass, and upon a colt, the foal of an ass."

That event was seen as certain to occur. The Creator of all things, and the true King eternal, was to be recognized, and welcomed by His dependent creatures, and had any power or authority intervened to prevent, or silence the glad acclaim of the people, the very stones on every hand would have had their tongues unloosed, and would have been heard singing His praises.

Tongues in Trees

Truly, there are "tongues in trees, books in running brooks, and sermons in stones," for God has placed them there, and when He will, can make us hear them.

"And Joshua said to all the people, Behold this stone shall be a witness unto us; for it hath heard all the words of the Lord which he spake unto us; it shall be therefore a witness unto you, lest ye deny your God" (Joshua 24: 27).

And the Prophet Habakkuk declared, chapter 2: 11, "The stone shall cry out of the wall, and the beam out of the timber shall answer it."

Everything Vibrates

Every created thing is in a state of vibration, and has in it the possibility of utterance. All that is needed for us to hear the tongues in the trees, and the sermons in the stones, is to have the compass of our hearing broadened, and our nerve centres quickened into such a delicate state of sensibility, that we shall be able to hear the waves produced by the atomic vibrations which exist everywhere about us.

Every particle of matter, however small, even down to the molecules, atoms, protons, photons and electrons, has received the impress of the power and praise of its Creator, as truly as we leave our impression on our work, and when He wills He is able to make us hear, and to recognize it acclaiming Him.

Suppose the disciples of Jesus on that day had been intimidated into silence, and immediately the stones, and trees, were heard crying out the praise of Jesus!

What astonishment, awe and consternation would have seized the multitudes, and the envious Pharisees, had they heard the rocks, from their million-molecule tongues, and the sands beneath their feet, and the grass, and the flowers, and the leaves on all the trees, and the brick and stone in the buildings, and the waters in the brook Cedron all voicing the praise of Christ!

There would have been no jarring, discordant notes in that symphony. For the multitudes to hear it, all that would have been necessary was a miraculous broadening, and quickening of the people's sense of hearing. Instead of hearing only twelve octaves of

vibrations, as most people do, they would have heard fifty or sixty.

It would have been similar to the quickening and broadening of the visual powers, rods and cones in the retina and the nerve filaments, in the eyes of the servant of Elisha at Dothan, which enabled the young man to see that there were horses and chariots of fire round about Elisha.

Then the people would have heard the sky itself, and all the clouds, along with every other thing, singing a welcome to the King, and their Creator.

Stones Speak to Those Who Have Ears to Hear

The poor dumb ass was given visual powers to see the angel standing in the way with a drawn sword, but Baalam, its master, saw nothing. Three times the creature tried to avoid the angel, and when it was brutally treated by the ignorant, unsuspecting Baalam, the ass was made to speak so that the covetous prophet could hear it, and even then in his ignorance, he was greatly angered at the ass, and felt like killing it on the spot. But then his own visual powers were quickened, and he also saw the angel, and heard his voice, and in fear and shame fell flat on his face.

Stones all about us have their messages. Stones in cemeteries mutely speak to us concerning those who have gone from us. They tell who the persons were, where born, and how they were related to other men and women, who possibly reared the monuments, and had a few loving words inscribed thereon, which tell the favourable characteristics of the departed.

Cenotaphs on marble or bronze in public squares, in halls, churches and public buildings speak of the achievements and exploits of benefactors.

But also stones which have not been carved by the hand of man, speak to us. Mountains and cliffs tell us of great upheavals of the earth; or mighty forces which rent asunder the stratified rocks, and lifted them high into the air.

Smooth stones on the seashore tell us that they have for ages been washed to and fro, until all their sharp and angular shapes were worn away, and that they have been restless travelers since the time when they were split from the mountains, and cliffs, and now they are the almost polished children of some vanished headland, which was far distant from where these neglected orphans lie.

Some say to us that they are marble, and other forms of lime rock, and that they bear in their bodies the skeletons of their ancestors, which were marine animals, and that these in myriads fell to the bottom of the ocean as ooze, or were swept by great floods into heaps, and were buried under mighty rocks, and were subjected to the internal heat of the earth, until they were thoroughly baked, and welded together, and at last formed into fine grained marble, interlaced with variegated colours, transmitted to them from their vegetable and animal ancestors.

Some of these were put into buildings, and became marble fronts for governors' mansions; other were cast into the fire, and turned into lime, and were made into mortar to hold together the marble slabs, and the brick and stones in the fine homes of the rich.

Chalk Speaks

Some of this was moulded into sticks of chalk, which were used to work problems in mathematics, and to conjugate verbs on the black-boards in schools, and

thus speaking their messages to others, but not saying a word as to their own ancestry and interesting history, until perchance one day, a boy broke off a piece of chalk and put it under a lens, when lo! it revealed to him its multiplicity of tiny shells, and he cried out: "I have the secret of this piece of chalk! It tells me that it once lived in the sea, and is really a graveyard, consisting of countless skeletons of its forebears, all crushed and broken, and crowded together in a heterogeneous mass! It is a wonderful story, and I wish I knew every word of it!"

Other Rocks Tell Their Story

Their story is a very different one from the above. An amateur geologist from a high school saw a rock on the shore of a river, and said to his younger brother: "Because of my few lessons in geology, I am able to know what many of the stones are saying. For instance, here is one," and he picked up a piece of shale rock, and struck it with his hammer. "This tells me that it was once clay, and some sand was washed upon it, and some ferns grew near by, and fell over into it, and here are their outlines as perfect as can be, even some of their brown spores are seen in the stone. The hot sun baked the clay into rock, and after many ages, it was broken into fragments by the ice of the ice-age crushing against it, and this piece was washed along the shore of this river, and I picked it up and split it with my hammer, and here in its heart is hidden a fern, and near by the fern is the track of a bird which walked over the clay, when it was yet soft. Every stone can tell its own story."

But stones can thus talk to only those who have sufficient knowledge to enable them to discern the mes-

sages. One can walk among objects on every hand, which are proclaiming facts concerning their history, and yet be utterly unconcerned, for nothing speaks to him. He can no more understand what is being said to him, than an unlettered Hottentot can understand what a printed page says to him.

Mines of Ore Cry Out

Deep in the heart of the earth are large masses of iron and other ores. These are mined, and cast into furnaces, and smelted, and then poured out, and run between heavy rollers, and flattened, and drawn out into thin, beautiful wires. These are strung over critically selected, and carefully constructed sounding boards, as in pianos and other musical instruments, and then a few correct strokes from a musician fall upon them, and you hear the iron, which was once hidden in the earth, cry out: " Praise God from whom all blessings flow! "

Or, if the ore mined from the earth were copper, and the resultant wire were wound over a soft iron core, to form an induction coil, you hear that mineral now voicing the words of wisdom of an orator over the radio, or giving utterance to a beautiful song as it vibrates an iron diaphragm in an ear piece.

The Hallelujah Chorus of the Trees!

In several ways the trees sing the Hallelujah Chorus. The simplest way is by their being felled, sawed, planed and glued into sounding boards for musical instruments, as pianos and other stringed instruments, or as pipes for organs, in which case the wood responds to, and reinforces the strains of the chorus played over them.

Then, too, the very molecules of the sounding board,

or violin perchance, marshal themselves into harmony with the strains of music which sweep over them. "If in the mind of the violinist there are melody and harmony of a high order, they find their way through the fingers into the bow that touches the strings, and all the molecules of the resounding wood waltz into harmonious forms. What a spectacle for the eye of reason to see all these molecules begin to form into line, and step out to the chord of sweet sounds, born of the mind of the musician." [1]

The Song of Colours

But the trees, and all flowers and leaves sing in another, and very real sense. It is known that all colours are produced by vibrations, which impinging upon the rods and cones in the retina of the eye, cause impulses to pass over the optic nerve to the brain cells, and these impressions we term sight. These vibrations, whether simply those of the ether, or are caused, as is now thought, by the photons in atoms, all have different rates, as do vibrations in sound. The red are the slowest, and the violet the most rapid. The colour red corresponds to the bass notes in music, and the violet with the highest notes. The rate of vibration is from 434 trillion per second in the red, to 740 trillion in the violet.

And so it is that all colours are really music of a very high pitch, too high for our ears to detect. But there are ears which can hear them.

Starved Leaves

In the early spring and in the late fall, when the slanting rays of the sun do not favour the development

[1] "Electricity and Its Similitudes," the Author, p. 106.

of chlorophyl in the leaves, which causes the green colour, the leaves have a red or brownish colour, or yellow or some other colour rather than green. The leaves starve unless they have the sunlight.

And in their starving condition they cease to labour. They are no longer able to break up the carbonic acid gas, separating the carbon from the oxygen, so as to take in the carbon for building up the woody fibre of the tree and giving out the oxygen, which is requisite for animal existence.

But rather, in their enfeebled condition, they exhale the carbon and inhale the oxygen which sets them on fire, a slow fire to be sure, and they accumulate starch which in contact with the oxygen turns into yellow and red, and they perish, but they do so in a flame of glory. They die gloriously, often exhibiting all the prismatic colours, one shading off into another.

They really die singing, going up the scale from the deep bass in the red, through contraltos and altos in the orange and yellow, and the high tenors and sopranos in the indigo and violet shades. What a glorious orchestra is an autumnal forest! The Psalmist expresses the truth when he says of the trees of the wood: " Then shall all the trees of the wood rejoice " (Psalm 96: 12).

Atoms Record and Repeat

Doubtless the multitudes, who heard Joshua say that the stone had heard the words of the Lord, and would be a witness as to the faithfulness or unfaithfulness of the people, thought that the stone would be simply a reminder of the solemn promise which they had made that day. Seeing it, would help to remind them of their covenant with God.

But it was more than a reminder, it was a witness.

It received the impression from God's words, and from theirs, and in due time could yield up the same.

The way stones, and all other objects, can listen, receive impressions from us into their very heart, and later render up their intangible and invisible secrets, is illustrated by the telegraphone.

The Telegraphone

" Words are spoken into a telephone terminating in a tiny electro-magnet, with a needle point. This rests upon a steel wire, or a steel disk, which is revolving.

" When words are spoken upon the telephone disk, the sound waves are transformed into electric pulses around the wire in the electro-magnet, and this magnetizes the electro-magnet.

" Then the electro-magnet magnetizes the atoms of the steel passed over, and these swing around into harmony with the magnetic waves falling upon them; being closely crowded together, as they are in the steel family, when once they are forced into a new position, they cannot easily turn back again into the old one from which they were twisted. They must wait for the master hand which put them there to touch them again." [1]

This occurs when the disk, or wire, is caused to revolve with the needle resting upon it, and then the needle point is remagnetized by the atoms of the steel, and these magnetic impulses cause the telephone disk to vibrate, causing sound waves, and so the atoms of steel are heard speaking or singing the messages which were hidden among them.

If by such a simple process, one's words and thoughts may be impressed upon steel, and yet be wholly invis-

[1] " Through Science to God," the Author, p. 250.

ible and intangible, until the proper contact is made with the steel, and then all are minutely reproduced, what may we not expect regarding the impression which we make upon every object with which we come into contact?

Light Registered in Glass

Gold-leaf letters were placed upon a plate glass shop-window. After a time these were removed, when it was discovered that the lettering had become fixed within the molecules of glass, and could be easily read, although the surface of the glass was perfectly clean.

Light falling upon us is reflected from us, and carries images of us, our looks and acts, and these are impressed upon all objects touched by the light vibrations in their endless journey.

We, with all our limitations, are able to fix many of these upon plates which we coat over with certain chemicals, and then to develop the pictures which the light waves deposited upon them.

Light Carries Pictures

But all light waves carry pictures, and all objects receive impressions from such waves.

The entire illimitable ether of space, as has been learned since radio was discovered, is capable of receiving, storing up, and of transmitting the impressions from all kinds of energy.

Sound waves are readily transformed into ether waves, and appear as light waves, or passing through the ether as electric particles, are again transformed into sound waves, and so the ether becomes a limitless storehouse, or reservoir, for the receiving of and transformation of energy in an endless variety of ways.

Sounds, physical actions, and even thoughts are registered there, only to give up their secrets to any and all receivers that are correctly attuned to their note, which may intercept them in their progress through the inter-stellar spaces, and through all material things as well.

A complete record of each one of us, from the moment of our birth, until the end of life here, is imparted to and received by this mysterious ethereal medium, and receptacle of all kinds of energy. It surrounds us like the air we breathe, and we can no more shake it off, or escape from it, than we can get away from ourselves.

It is a book recording our lives, and which is written all over, and in every part, with what we do, and think and are. And so we live as truly on Uranus, or in the environs of the Pleiades, or beyond Arcturus, as we do on this earth; and when a few words are carved on marble, in a cemetery, as to our birth and death, our full life in all its detail will be read and recognized in the heavens above, and beyond, through endless ages.

And so the whole universe becomes a sensitized plate which receives the impressions which we make upon it. Every touch, every act, and every thought is registered there, awaiting the time when this book, which is the record of our lives, shall be opened at God's great assize.

That which we did eight minutes ago, was caught by the light, and carried into space. It has not quite yet reached the sun. It will take seventy years before it arrives at the North Pole-star, and a million years to reach the Island Universe in the Nebula of Andromeda. And all the way along it will record the story of what we did and said. And this is true of

our every act, and thought, and word of our life from the cradle to the grave.

How would we feel, here and now, to have some one come along and read and hear, from the stones, and leaves, and trees, and from the earth and the air the record of everything which we have thought or done during the past week? Then to have the whole record of our life, from its beginning to its close, revealed, seen, read and heard, by all the assembled hosts of heaven, would be appalling. Some good things, many fine ones are in that record, but there are many unholy thoughts, many unkind and sinful deeds, long since forgotten by us, which we would shudder to have our best friends see and hear.

Our Secrets Revealed

What an amazing thing to have God unlock the myriad molecule-tongues in that stone, which Joshua placed in Shechem, and which heard the words of the covenant with the people, and then to hear it tell of the impressions which it had received of their unfaithfulness, their idolatry, and cruelty, and for each one to recognize himself in the words uttered by the stone!

And to see himself reproduced more accurately than he could discern himself in any photograph of himself which was taken a month before! To hear his own words of the past as distinctly as if they were only spoken an hour ago! And then to think that such might be the case, not with one event, or the record from one stone, but of everything done in life, and read from everything about us, from the air, and the limitless ether itself, is almost too harrowing to contemplate. And yet it is wholly possible, and is in harmony with the facts of science, as understood in these days.

The Record Erased

But there is one very consoling possibility open to us in these thoughts, and that is illustrated by the telegraphone, to which we have referred.

When words are uttered into the telephone, and recorded in the atoms of the steel disk, the disk can be removed, and be sent to another person at any distance, and when placed by him upon another instrument, and caused to revolve, the electro-magnetic needle will reveal the words uttered upon the disk, and this may be repeated any number of times.

But if one wishes the record which was made upon the disk, or the wire, as the case may be, to be obliterated, all he needs to do is to have a permanent magnet touch the disk as it revolves, and then all the atoms of the disk are magnetized alike, and the record is wholly eradicated.

Light Turned to Darkness, and Sound to Silence

The record on the steel is as utterly blotted out, as we know that two waves of light, or two of sound, are obliterated, when the crest of one wave is made to fall into the node of another, and that which was formerly light is now darkness, or those which were waves of sound leave nothing but silence.

And so He to whom all things are possible, can cause waves to meet those which have been set in motion by our lives, and are speeding onward through the universe, and as these coalesce, our unworthy record would be gone.

David prayed: " Blot out mine iniquities " (Psalm 51: 9). And God's loving promise to His people is, " I, even I, am he that blotteth out thy transgressions for

mine own sake, and will not remember thy sins" (Isaiah 43: 25). And Peter says (Acts 3: 9) "Repent ye therefore, and be converted, that your sins may be blotted out."

Who would not gladly accept that invitation, to have every unworthy thing recorded against him, blotted out? It can be done instantly, and the marvelous magnet in the hand of God, which touches our sins, and lo! they are gone, is through the atoning sacrifice which Christ made for us on the cross,—it is His shed blood, or yielded up life on our behalf, and apart from that, there is no remission of sins. Only that is sufficient to send them into oblivion, to be seen or remembered no more. And all that may be had on our surrender to and acceptance of Him, as our Deliverer from sin.

Questions for Review

1. What incident in the life of Jesus gave rise to the statement by Him, "If these should hold their peace, the stones would immediately cry out"?
2. Was that statement simply and solely a figure of speech?
3. Is there any real sense in which there are "tongues in trees"?
4. Were stones ever used as a witness of a promise by people? If so, when?
5. Since everything vibrates, why can we not hear those vibrations?
6. What would be necessary in us to enable us to hear the vibrations of the molecules and atoms?
7. Is God able to make men hear these vibrations in nature?
8. What prophet had his visual sensibilities so quick-

ened that he saw what is usually invisible? In answer to his prayer, what else occurred?

9. What animal saw an angel? What was the name of the prophet who was riding the animal? What occurred to him?

10. To whom do stones now speak?

11. Name stones which speak to the living concerning those who have died. How do we come to understand their messages?

12. What other stones declare their messages to us? What do smooth stones by the sea say?

13. What do lime rocks declare of their history?

14. How does chalk speak? Illustrate its history. Under a microscope, what does it reveal?

15. What do other rocks say to a student of geology? Give an illustration.

16. Who only can understand what such stones say?

17. How do mines cry out? Give an illustration of how this is actually done in human experience. What of copper?

18. How do trees sing their hallelujah chorus? In what instruments? Is there any other way?

19. What of the song of colours? What in the eye responds to the vibrations of colour?

20. Which are the lower notes in the colour scale? Which the intermediate, and which the higher? Name their rates of vibration.

21. When are leaves starved? What occurs in them then? Explain the process and why.

22. What do leaves do while they are dying? What did the Psalmist say of trees rejoicing?

23. Can atoms record and repeat?

24. How does the telegraphone work? How does that explain how stones may become witnesses, and repeat messages?

25. Is light ever registered in solid substances? Give an example.

26. When light is reflected from us, what does it carry away?

27. What kinds of energy are stored up in space, term it ether, or whatever we may?

28. What modern instrument transforms inaudible waves into sound waves? Can light waves be transformed into sound waves?

29. What about the record of our lives in the ethereal medium which surrounds us?

30. What in photography is likened to the universe, and why?

31. Give illustrations of the speed of the pictures of ourselves which are being carried away from us into space.

32. Do we enjoy having all our secrets known?

33. What book of our lives could God open so that all the secrets about us would be revealed?

34. In the telegraphone, how are the records which are made in steel obliterated?

35. Can light be turned to darkness? When and how? Can sound be turned to silence? Explain.

36. What do these scientific facts teach us regarding sinful records? For what did David pray?

37. What can become of our sins? Who can do it, and when?

VII

LICHENS

AFTER numerous agencies had for ages operated to grind down the rocky surface of the earth, there appeared vegetable pioneers to aid in the process of soil formation. These we will next consider.

In country districts, where the air is pure, who has not noticed a plant growing upon stone walls, and frequently, though not correctly, called moss?

Its greyish patches are seen upon the body and limbs of trees, on the stones of old walls; on tombstones, often, however, as only a slight discoloration.

They grow on the ground, on mosses, and sometimes on perennial leaves. These important little plants, of which over four thousand species have been described, are termed lichens.

What, Where?

They find their habitat in all portions of the world; in the arctic regions, where they form by far the largest part of vegetation, on the burning sands of deserts, and in the torrid valleys of tropical climes. Upon the highest mountain elevations yet attained by man these forerunners of plants, flowers and forests, may be seen clinging to the otherwise barren rocks, even far above the snow-line.

They grow upon all kinds of cultivated ground, from the sands by the seashore, to the loose fragments of detritus on the lofty mountain sides.

Some lichens seem quite indifferent to the substrata on which they occur; for they may be found on the bleached bones of reindeer, and marine animals, on glass, iron and leather; and in open districts, few trees can be seen which do not bear traces of them.

And we more than half suspect that Samuel Woodworth's poem, which was so realistic and picturesque a generation ago, but is fast becoming meaningless to us city folk, with our painted hydrants and polished faucets, and which ran:

"The old oaken bucket, the iron-bound bucket,
The moss-covered bucket which hung in the well,"

was not moss-covered at all, but was the abode of our tiny and vigilant friends, the lichens.

Some have been found growing on other lichens as parasites, and a few are met with, known as erratic species, which are growing unattached to any substratum.

They people the air with their multitudinous spores, so light that the least breath of wind causes them to soar aloft, and wait for a time of perfect calm, that they may fold their wings, and find a resting place for their weary feet. But as a matter of fact they have no feet, unless their whole sticky body may be termed feet; for they have no true roots, like most other plants.

While it is true, as we can readily believe from the numerous objects upon which they are found in all portions of the globe, that their geographical range is more extended than that of any other class of plants, yet it is noteworthy that they eschew the thickly crowded haunts of man. They can rarely ever be seen in cities where the atmosphere is impregnated with smoke.

A family so widely diffused over the surface of the earth, and so numerous in the variety of its members, deserves our attention. And although it is apparently insignificant, and does not attract our notice, as do the flowers and fruits of other plants and trees, yet when we begin to inquire into its life history, and its mission in the realm of nature, we feel like baring our heads in the presence of these children of nature whose hoary ancestry takes us back to the dawn of creation, and who toil in behalf of all vegetable and animal life; and there is aroused in us an admiration for them which is not surpassed by the famous cedars of Lebanon, or those mighty giants of the forest, the Sequoia of California.

" Written with the finger of God," is what we would feel like exclaiming, if we were able to read the hidden and deeper meaning in anything which God has created. Everything which He has made has its meaning and message to us. It was written with His finger.

There is one tribe or species of lichen, the graphidacei, or " letter lichens," which are so named from the script-like form of their fructification. They remind us of the wedge-shaped, or arrow-head cuneiform characters in the writing of the ancient Accadians of Mesopotamia.

Usefulness

Let us seek to read some of the messages which the lichens bring to us. In the first place, they command our respect, and awaken our admiration and gratitude because of their usefulness. They seem to say to us, " Nothing is so lowly, or so obscure, but that it may be useful. Be genuine, be useful, and some one at some time will thank God for your creation."

In the economy of nature they not only serve for the first commencement of vegetation, but they prepare the way for all others.

Let us climb the rugged sides of a mountain, until we reach that portion above the grassy slopes which lies at the base; above the rude cottages of the shepherds, and further than any hoofed animal can go, above the glaciers grinding their way downward between the mountain peaks, above the last mountain climber's hut, and even above the line of perpetual snow, and there we shall behold rocky peaks which thrust their heads above the snow and ice, shake them free from their sides, and rise into the clear cold air beyond, above their surroundings, in almost perpendicular cliffs for thousands of feet. They seem to be impatient of the contact of any animate or inanimate thing.

In imagination stand upon the rocky crown of such a mountain so barren and desolate, and look down upon the grassy fields far below, where the sheep and cattle are grazing. The shepherds' cottages, with gardens and flowers, cling to the grassy slopes. We see luxuriant vineyards with their ripening fruits, springing out of the rich soil upon the sunlit slopes, and further away are the fertile valleys filled with life and activity. The sound of the shepherd's horn, the blare of the military bugle, and the hum of commerce are heard in the distance.

Once all this scene spread out before us was as lifeless and barren as the rocks upon which we stand. And the fertile soil in the valleys and plains below came very largely from these lofty peaks about us. All the soil had to be made out of the solid rocks such as these upon which we stand.

Here the steel plows would be useless. The drill

and blasts and hammer of the stone-breaker could accomplish little toward pulverizing these rocks into dust sufficient to make fertile soil. No seed of tree or of flower could find a home here. And once the whole surface of the earth was as barren as these rocks. How then was the change wrought?

First Farmers

The first tillers of this inhospitable farm were our tiny friends, the lichens. Look about you upon these rocks, and you will discover the descendents of those hoary ancestors who first began tilling the rocks in those far-off ages.

Their descendents look like mere stains in appearance, and it will be a long time ere they will resemble the plants on the old stone-wall fences, and the "moss" on the old oaken bucket far down in the valley.

But look about you and you will discover larger growths. Take hold of these, and notice how rough and hard they feel. This is owing to the large percentage of mineral matter of which they are composed, it being more than one-fifth part of their substance.

Pull one from its foothold on the rock, and notice how it clings. It seems almost cruel to rend it from its mooring. You discover a pit-like depression in the rock from which you have torn it.

The process by which that slight depression has been formed is the same as that by which the fertile soil of field and vineyard has been produced.

Long ages ago countless multitudes of invisible spores, which in the lichen correspond with seeds in other plants, were floating in the atmosphere. At a moment when the air was perfectly calm, some of

them settled upon the hard surface of the rocks, and being sticky, they clung fast, and began the task of sustaining themselves, and of transforming the rocks into soil.

To unlock the mineral matter held in the bosom of those rocks was no slight undertaking, but they were well equipped for the work. It is a well-known fact that the roots of trees and plants, being acid, tend to dissolve the minerals in the soil in which they live, and by their root-hairs to absorb as much of the minerals, in solution, as they require for their own upbuilding. And that is precisely what the lichens do, although they have no roots. Being strongly acid, they dissolve the rocks and incorporate as much of the minerals in solution as they need, and the remainder is washed by the rains down to the lower levels to help form the soil in the valleys.

And thus as generation after generation of lichens live and die, they wear away the rocks, and by their own death and decay help to form a soil into which plants of a higher order may take root and thrive. Being pioneers of vegetable life on earth their mission has been to prepare the way for other forms of life, and most wonderfully have they performed their allotted task.

Others have increased, commanding attention by their beauty, like the flowers, and by their grandeur, like the forests, but these have decreased until they have taken a place so humble and subordinate, that they are little known or noticed in the earth, even by those who daily trample them under foot. And they silently continue their humble and beneficent work of eating away the rocks, and are continuously adding to the depth and fertility of the soil.

Vicarious Sacrifice

Their life is substitutionary. They live and toil and die for others. They prepare the way for others that are to come after them. They remind us of John the forerunner of Jesus, who did such an important and humble service, and was highly commended by his Lord. We may not be able to perform something great for God and humanity, but it is no small service which we render if we prepare the way for some one else, by making it easier for him to do his work and serve God. Like the great Creator Himself, and who has made it the law by which all living things must attain their highest and noblest ends, we can in our life and death, perform a substitutionary work for others, and become for them stepping-stones to a higher life and service. We may be their forerunners, enabling them to do what otherwise they would never be able to perform.

Something decidedly more than the acidity of these tiny workers is necessary to enable them to produce the pit-like depression found beneath them on the rocks, and to account for their vast results in the softening and dissolution of their flinty hosts, the rocks.

A solution containing no greater percentage of acid than is found in the lichens would make no such impression on the rocks as they do. But they possess one very important element which enables them, and all other plants, to perform tasks which would be impossible to the chemist, and that is life.

Vital Force

It is the life in these plants which enables them to perform such wonders. Life is the difference between

them and the rocks on which they live. Life makes them the masters of the rocks. Life, though it may be in its humblest form, locked in the bosom of the lichen-spores, so small that a microscope is needed to detect their presence, still is a vast remove from the most perfect specimens of inorganic matter, such as diamonds, gold and silver.

The lichens teach us that life may be placed in the most unpromising surroundings, and still it will work its marvels. That is characteristic of life wherever found. It is superior to its environment. It is a conqueror. It overcomes its oppositions, and an adverse environment, and by means of them, mounts higher.

Even in contact with disease, all that is needed to make one immune, is to possess an abundance of life. This is particularly true in the spiritual realm. Heredity may present its handicaps, environment oppose, and personal habits be at war with the spirit, but give one life, the life which is from above, the life of God, and he will transform all his handicaps into helps, and will rise a victor above them all. It is life, not resolution; life, not training, mental or psychological; life, not good society and social standing; life, not money, position or fame, which takes one through life, and crowns him a conqueror at last; and that all conquering life is the gift of God through Christ, who made the lichens masters.

The lichens possess many characteristics which remind us of that life which Jesus taught that men can only receive from Him. "I give unto them eternal life, and they shall never perish." That is life from above, and is life indeed.

While the lichens live on the rocks, and other in-

hospitable materials, they obtain an exceedingly small percentage of their food from such sources. They draw their life from the air. Only in a minor degree do they depend on the world beneath them for their sustenance. Their message to us is, "Like us, you must draw your life from above."

Longevity

Again, they possess a marvelous longevity, having an indefinite existence, and age does not seem to weaken their fecundity. They multiply themselves even when the thallus has apparently ceased to grow. The oldest fruits are never destitute of spores, and these contain the living germs.

They apparently have no cause of death in themselves. It only comes to them from without.

Their growth and development are a sure index of the purity of the air; for they do not dwell in an atmosphere impregnated with smoke and foul gases.

In times of drought they merely exist. They require refreshing showers.

Each one of these traits speaks its message to us of that higher life, which we receive by faith in Christ, as clearly as if it were written with the finger of God.

That life imparts longevity to its possessor. True Christian faith prolongs one's life; for it banishes destructive habits, imparts a serenity to the mind which is favourable to the continued and uninterrupted action of the heart, inhibits worry as being distrustful of the goodness and care of God, and fosters faith which combats disease. And such an one is sure to exist longer on this earth than he otherwise would. He knows that also within himself he possesses a life which can never die.

And advancing age does not destroy his powers for usefulness. He is never destitute of life-imparting tendencies. He brings forth fruit in old age. That kind of a life creates in others the desire to possess one like it.

The life of God is incarnate in such an one, and it is beyond the reach of death. Death is an exterior enemy, which can only smite the body, releasing the spirit for its home in the spiritual body where it dwells unfettered and untrammeled in the presence of Christ its author.

The development of one's spiritual nature is a sure index of the atmosphere in which he dwells. He cannot reside in a foul atmosphere and grow. Impure thoughts, low companionships, secret sins, unforgiveness, selfish and pampered lusts, all stunt the growth. If there be no growth in the graces of Christ, look well to the atmosphere. A new envirnoment is needed. In companionship with Christ one always finds a healthful atmosphere.

Long droughts are as deleterious to a Christian as to the humble little lichen. There must be times of refreshing from the presence of the Lord. Without these one merely exists, and mere existence is never a happy or ideal state.

And last of all, real life always makes one useful. That is the predominating characteristic of the humble lichens. They possess wonderful nutritive qualities.

Food Value

In some regions they are an important factor in the food supply for men and animals. This is owing to the fact that they contain, in some cases, a small quantity of saccharine substance of the nature of mannite,

a crystalline compound with a sweetish taste found in celery and other plants, and they always have a large percentage, seventy to eighty, of amylaceous substance, lichenin, or lichen-starch, which possesses the same elements as common starch, isomeric with it, but not having its appearance.

This is particularly true of a lichen termed Cetaria islandica or " Iceland Moss," so called, doubtless, from its appearance to moss in its leafy erect posture. It grows in all northern countries, even down close to the sea, and in mountainous regions where it thrives abundantly. It especially grows profusely on the lava slopes and plains of Iceland, which are devoid of other vegetation. It is from three to four inches in height, and has a slightly bitter taste. This is removed by boiling, the first water being poured off.

It is sometimes pulverized and made into bread, or it may be boiled with milk, making a kind of jelly, and is most agreeable as an article of food which is particularly suitable for invalids.

It is said that in Iceland numerous parties migrate in the summer for great distances with their horses, tents, and provisions, for the purpose of gathering it as an article of food, and for commercial purposes.

But the most remarkable esculent lichen of all is the " manna lichen," which in times of drought has served as food for large numbers of men and animals on the arid steppes in various parts of Africa, Russia, and South America. Charles Darwin in his " Journal of Researches," which he made in the *Beagle* round the world, states that while traveling in Peru across a complete and utter desert, where the bones of animals that had perished there lay strewn about at an altitude of two thousand feet, that he saw the loose sand here and

there covered with a lichen which lay unattached. It was in sufficient quantity to tinge the sand, when seen from a distance, imparting to it a pale yellow colour. In a distance of forty miles or more, the only vegetable he saw was another species of lichen growing upon the bleaching bones of animals.

"Manna"

Some authorities see in the "manna lichen" the manna of the Bible. It is certainly a most wonderful provision which God has made to sustain the life of man, the camel, and other animals, upon those seas of sand so devoid of water and vegetation, "where it grows on the ground unattached in layers from three to six inches thick over large tracts of country, in the form of irregular lumps of a greyish, or white colour."

"It sometimes forms on the sand, in the morning, a layer one or two inches in thickness, and appears to have dropped from heaven, or to have sprung spontaneously from the soil during the night. It is probable that its spores, transported by the wind, are developed by the humidity which is condensed through the nocturnal coldness."[1]

In Lapland, and other northern countries, it forms the chief source of winter food for the reindeer, and other animals, which paw away the snow, and eagerly devour it. In Carneolia, Austria, it is used for fattening cattle and pigs.

Lichens are no less useful for their commercial and medical purposes.

While all the lichens have characteristics in common, yet each one possesses its own peculiar traits. This is strikingly manifest in the selection of their home, and

[1] "Desert World," Arthur Mangin.

environment. Some choose the bark of rugged trees, while others prefer to live on the smooth bark of young trees and shrubs. One kind will seek its abode in large forests, while another is found on trees by the public highway. Some like to live on rocks, and others on various kinds of soil; and some, like shiftless specimens of humanity, seem utterly indifferent to the nature of that which forms their abode.

Yet these strange differences are not the result of chance. There is a destiny which shapes their end, rough hew them as they will. They can perpetuate themselves, and reach the goal for which they were started in life's race by the Creator, only by finding their own place in the world, and by developing in their own way.

Is it not so with us, the highest of God's earthly creatures? We attain our noblest end by finding that place in life for which God has fitted us, and by developing ourselves according to our own particular predilection, rather than by the imitation of others.

There is locked within the tiny germ of our being that which is possessed by no other mortal; and if it unfold the way God intends, while in a measure like all His children, we shall be like no one of them.

We are like the lichens, too, in that which will nourish one will starve another. We should, therefore, find the place in life which is suited to our peculiar needs, and which will best minister to our needs and growth.

Duplex Existence

A lichen has a peculiar duplex existence. Its compound organism consists of a fungus, and an alga living in symbiosis, that is, the consorting or living together of dissimilar organisms, each dependent on the other.

The alga can, and the fungus cannot live independently. Simon Schwendener, and others, go so far as to maintain that one part of the lichen is a parasite thriving at the expense of the other. According to them, a lichen is not an individual plant, but rather a "community made up of two different kinds of individuals belonging to two distinct classes of cryptograms, namely, a master fungus, and colonies of algæ slaves, which it has sought out, caught hold of, and retains in perpetual captivity in order to provide itself with nourishment." [1]

Whether this theory, as to lichens, be entirely correct or not, we know that it is often the case with mankind. We are complex beings, composed of spirit, mind and body. The spirit and mind or soul may exist independently of the body, but the body cannot exist apart from them. God intends that they shall live together in the most beautiful symbiosis, each one performing the task designed for it, to the blessing of the others.

We know how dependent they are upon one another. If one suffers the others suffer with it. If the body be diseased, the mind is impaired, and the spirit depressed. The knowledge of this fact should lead to the maintenance of a correct balance of relationship between them.

Yet how often this is not the case. The body, fungus-like, seizes the mind and spirit, and holds them as captives, and insists that all their energies shall be devoted to its development, or to the pampering of its lusts.

Again, and this is but a step higher, the body and mind may be given full control, to the utter neglect of

[1] Encyclopedia Britannica.

the spirit upon which they are parasitic. In this case, the spirit is held in perpetual servitude to the mind and body. And the one in whom this occurs may cultivate his mind, utterly ignoring the yearning and whispers of his spirit, until after many years he concludes that he has not, and never possessed any such a thing as a spirit or inner man, distinct from his mind and body. Then without any misgiving he can entertain opinions, and express them, regarding the non-existence of God, and the unreality of a future life, which, in his earlier years, would have filled him with dismay.

His spirit has been captive so long, lying in a dungeon under the accumulating rubbish of a lifetime, that he has utterly disqualified himself from knowing the truth, because the only part of himself which could apprehend God, or experience spiritual truth, has become atrophied by disuse. The beloved naturalist, Charles R. Darwin, during his last years, gives us a pathetic picture of himself as in precisely such a condition.

Questions for Review

1. Where in country districts may lichens be seen growing?
2. Name some of the habitat, and the appearance of the lichens.
3. What are their seeds termed?
4. What as to the lightness and size of these spores?
5. What are the "letter lichens," and of what Scripture statement do they remind us?
6. What do these pioneer vegetables seem to say to us?
7. How do they appear at first on mountain peaks? What was the original appearance of the earth from such peaks?

8. Describe the appearance of the hoary ancestors of all vegetation.

9. How do the lichens feel to the touch when torn from their foothold on the rocks? Why is this?

10. What is the appearance of the place from which they were torn?

11. What was the first process of their work on rocks?

12. What is the result of their dwelling on the rocks?

13. What do they secrete which aids them in their toil?

14. In what way are their lives vicarious?

15. Of what famous forerunner do they remind us?

16. How do they teach us to make our lives stepping-stones to higher things?

17. What beside acidity is necessary to enable these tiny workers to perform their tasks?

18. What do they possess which makes them superior to even the highest and most valuable minerals?

19. What does the possession of this same force do for us? Give examples.

20. What is the chief source of life to the lichens? What does this teach us?

21. What can you say regarding their longevity?

22. What is their presence an index of, as to the atmosphere? How do droughts affect them?

23. What do these various characteristics suggest to us, as to our lives? Name several of them.

24. What is true regarding the food value of lichens? What substance do they contain which gives them these food qualities?

25. What is Iceland moss? Why is it valuable as food?

26. What is the most remarkable of all food lichens? What does Charles Darwin say concerning it?

27. With what, in the Bible, do some believe this lichen to be identical? Describe its appearance.

28. In what regions is this a chief source of food for animals? Give illustrations.

29. What about the differences between lichens? How is this a reminder of the differences between men?

30. Describe the duplex existence of lichens. Give the theories regarding this.

31. What do these characteristics in lichens suggest to us, as to the relation between our body, mind and spirit? Give illustrations.

VIII

MUSHROOMS

ONE step higher than the lichens, and requiring more soil preparation for their sustenance, but still very low down in the scale of vegetable species, are the fungi, or mushrooms, to which we next turn our attention.

It is believed that for at least 2,000 years man has made use of mushrooms as food. They have always been a highly esteemed delicacy. Gathering and eating those which have not been cultivated and have grown up promiscuously, is attended with grave danger, unless one is experienced in distinguishing them from what are commonly termed "toadstools"; for many deaths have resulted from eating the poisonous variety of these plants.

Toadstools

To the practiced eye they are readily recognized. They never grow in wet boggy places, or in the woods. They are not found upon or about the stumps of trees. In the wild state they are not generally large, being not more than four or five inches in diameter. On the under side of the cap are radiating dark brown, or dark purple gills, which are unattached to the stem. About the centre of the stem is a small ring, which is the remains of the cover it had when young. The stem is either solid, or slightly pithy, but never hollow.

The dangerous varieties are subtle in their appear-

ance and effects. They may be very beautiful. After the eating of them no ill effects are noticeable before eight hours, and from that to fifteen hours.

Vegetable Meat

Mushrooms are a vegetable meat, containing from 20% to 50% of protein, or nitrogenous material as food. They flourish in July, August and September.

Much has been learned concerning them in the past score or so of years. In 1873, Cooke, an English writer said that there were " several " varieties in the United States. The New York State botanist has investigated and described sixty-three edible varieties, and four poisonous ones, and there are credited to that state over 500 species of agaricus, or common mushrooms. There are numerous other species, and these are often erroneously called " toadstools."

The common mushrooms, agaricus, are cultivated in large quantities in France, and England, and in some other countries to a less extent. The Paris mushrooms are grown in dark underground caverns, from 50 to 150 feet below the surface. Manure is taken into these passages and spread upon the beds a few inches deep. Upon the top of this is placed a very thin layer of dry manure, in which the spawn of the mushroom occurs naturally. Each bed is covered with about an inch of fine white soil. They are kept moist by water conveyed from the surface.

Where They Grow

These beds are generally in caves, and sometimes twenty miles in extent and are so arranged that when the supply of the beds in one gallery is exhausted, others are ready to be gathered. In this way propri-

etors send up to the surface from three hundred to three thousand pounds of mushrooms daily. Not only the hotels, restaurants and private families are supplied, but large quantities are shipped to other places in Europe. Catsup is largely made of mushrooms, the juice forming the principal ingredient.

Under cultivation they often grow to a large size, and not infrequently weigh from twelve to fourteen pounds. Their culture is generally profitable, for they usually command a good price.

They belong to a low order of the vegetable kingdom; and live, as we shall see, in the slums of that realm. They are fungi, and belong to that whole group of organisms which cause the diseases of plants known as smut, rust, mildew and blight. They are parasitic in their habits. Looked at, through a microscope, a tiny cluster of mould resembles a forest of trees, and are exceedingly beautiful.

Spores

The spores, which correspond to seeds in higher plants, develop into fungi. They are microscopic, and are present everywhere, in the air, within and upon nearly every object; on grain as rust, on old paper and books which smell musty; on currant twigs and dead nettles as mildew; as smut on corn; as mould on cheese and old boots or shoes, on canned fruit, and in yeast, and all fermentation. They are in the air we breathe, and in the water we drink. They form the ergot on rye and wheat, and are parasites on flies, wasps and other animals. They even attack man, forming skin and other diseases.

All our garden plants and trees, our fruits and vines, our milk and potatoes, the silkworm and moth, are

subject to their destructive work, in which they may cause decay and death.

The life substance known as protoplasm, is the same in the fungi as in the highest plant, or even in man, and yet they are a very low order of vegetable life. If you should take a daisy to pieces under a microscope, you would see that, besides its roots, stem, leaves and flowers, it has layers or tissues, which are composed of a great variety of cells and fibres. It is not so with the fungi. They are composed only of cells. The fibres are absent. They are soft bodied, and often ill-looking plants. Their characteristics and mode of life, as contrasted with those in the higher plant or tree, are interesting. Let us consider some of them:

The Food of Fungi

The first is the way the fungi obtain their food. They have not the power to obtain it themselves, but get it ready made. Some of them board and lodge altogether upon other living bodies. These are called parasites. Others feed upon the products of waste and decay of other and once living bodies, and are called saprophites. Mushrooms are saprophitic feeders, because they live upon the decay and death of other organisms. We now see the reason for saying that they live in the slums of the vegetable world.

Higher Plants

How different it is with plants, or trees. They have a much higher existence. The roots, by means of the tiny root hairs, are absorbing water and other substances from the earth, while a similar process is going on in the leaves. The food thus obtained is transformed into living cells and fibres. While mother na-

ture furnishes the material, they receive and prepare the food, which sustains life and produces growth. They are hard workers, labouring with their own hands, and do not live upon the decay and death about them.

The distinction between them and the fungi is suggestive of the difference between the spiritual and natural state of man as taught in the Scriptures. He is unable to transform truth into a vital force. He knows his sin and his duty, but he lacks the ability to free himself from the one, or to do the other. At one time he is a parasite, not upon his Creator, from whom he was intended to draw all his life, as well for his mind and spirit, as for his body. He was created to live and move and have all his being in God. He lives on those who are as weak as himself, on their leadership, their opinions, and their meagre gifts, all of which are included in the phrase, "good society." He may, on the other hand, seek to meet the needs of his being by becoming a saprophite, existing upon the decay and death about him. In this case he ends by becoming a moral degenerate.

Such a life and work as are exemplified by the tree, are impossible to either one of these. To live and thrive in a higher realm, or kingdom, as Drummond interestingly portrayed, one must correspond with that realm, he must be like it; and this is possible to one in a lower realm only by his being born into the higher. In the words of Jesus, he must be born again, or from above. Yet, strange to say, before one can unfold into the strong, stable, free life, illustrated by that of the tree, he must become a parasite, living entirely upon the limitless life of God; for He is the only source of life.

The manner in which the fungi reproduce their life is interesting. The ordinary tree produces seeds. These have the parent tree in miniature locked within them, and when planted give origin each to a new tree. So that the development is direct from the tree to its offspring.

The fungi have no true seeds but spores, a dust-like substance which grows upon special filaments, which shoot up from the threads that form the essential part of every fungus. In some fungi the spores are set free, and help to form part and parcel of the great army of germs which the air-ocean bears.

When the mushroom is ripe, and its gills are dark brown in colour, they throw down a dark brown or purple dust, which are the spores. These produce thread-like filaments, which mushroom growers call spawn. From this spawn the mushrooms are developed.

Fungi live in only one world. All the substance which they receive comes from one direction, through their roots. They are never green, but white in colour. The possession of this green substance, called chlorophyl makes all the difference in the world to a plant. For when it does possess green matter, it can feed upon the materials drawn from two worlds, earth and air. In general, the food of such plants is water, minerals, ammonia, and carbonic acid gas, which can be absorbed only by cells containing chlorophyl.

The Green in Plants

It has been truly said, " Wonderful is the ministry of the green skin of plants. It changes inorganic into organic matter, and thus furnishes the starting point of all life. Nowhere else on the surface of the earth

does this important process take place. Everything else consumes and destroys; the green skin of plants alone creates and conserves."

Green is particularly the colour of life. It is only those cells which contain endochrome, or chlorophyl, that have the power to transform mineral matter into living cells and fibres. These green cells are on the outside of the plants, and give rise to the pleasant verdant appearance of the grass of the fields, and the foliage of the trees.

It has been estimated that about one-half of all the plants, 150,000, lack this endochrome, or chlorophyl. That is, they have not the power of transforming mineral matter into life. Wherever you see green on leaf, stem, plant, or on the exterior of unripe fruit, there the creative process is being carried on. And in proportion to the vividness of the green is the vigour of the process.

The presence of all other colours is an indication that the constructive process has given place to the destructive. Hence it is that parasitic plants, " which feed like animals upon organic compounds formed by their hosts, are never green, but of different pale brown or neutral tints. Hence too of the utter absence of a bright green hue in fungi, which have no power of decomposing and recombining the elements of nitro-carbon and ammonia, and consequently require to have their food presented to them in the form of organic matter."

In proportion as chlorophyl, which is characteristic of young and vigorous plants, becomes replaced with starch, which is characteristic of old age, in that degree does the plant change to the autumn hues, which means decay and death. As soon as the vital forces become

enfeebled, because of the slanting rays of the sun, low down on the horizon in the fall, starch begins to replace the endochrome.

Like Blood

This green matter has been likened to the red corpuscles of the blood. As the red blood circulates in the veins, through the action of the heart, so the grains of chlorophyl move in the cells of the leaves through the action of light. This is seen when plants are removed into dark places. There the green life process of deoxidation not only ceases, but is reversed. Now the plant absorbs oxygen, and carbon, the product of combustion, really the ashes from the fire, is given off. As a result the chlorophyl is slowly burned up, and rusts away into the various autumnal hues. The nearer to death the brighter and deeper the hues. Deep hues, as red, are always an indication of the presence of oxygen, that the fire is burning, as is seen in the red cheeks of one who is running. Then, because of the fast and deep breathing, he inhales larger quantities of oxygen. This is the process in all plants, leaves and fruit.

Two Worlds

Trees may be said to live in two worlds, earth and air. This suggests to us that so long as we remain in the natural non-spiritual, unregenerated state, like the mushrooms, we are living in only one world. Our whole life, joy and hopes are derived from this world. We are not in correspondence with the higher, invisible world, and hence know nothing concerning it. It has no existence to us. This is why it is that not infrequently men of keen intellect announce it as their

opinion that there is no life beyond this. No such world exists to them. They have never been born into it. They know only the mushroom life. They live in one world only, the natural. "The natural man receives not the things of the Spirit of God; for they are foolishness unto him: and he cannot know them for they are spiritually discerned."

How different is our condition after having received the new life from God. While still rooted in nature, and drawing even more from it than we did previously, we nevertheless lay hold of the world above, and build it into our being. Then it is that we are like a tree planted by the rivers of water, and bring forth fruit to God's honour.

Sunlight

Mushrooms, as we have seen, grow in cool dark places, caves being often used for their culture. It is not so with green leaves and plants. Only in the light can they increase their weight, and then only as they are supplied with carbonic acid gas.

All roots also absorb better while in the light. While taking in carbonic acid gas they breathe out oxygen. This process adds carbon to their structure and builds them up. They also require heat. When in a cold atmosphere they are like cold blooded animals in a dormant state.

This reminds us of another characteristic in the life of Christians. Only while they live in the light of Christ's presence can they live and grow. It is true that green plants can live for a time in dark places, and increase their weight, but at the expense of reserved materials which may be present in them. If Christians are seeming to grow while in partnership

with the works of darkness, it is certainly at greater expense to them somewhere else.

A cold indifferent state has the same effect on them that it has upon the plant. It makes them dormant, and growth ceases. As the roots absorb better in the light, so the Christian can best enjoy even this lower world while he walks in the light. He must be confident of God's approval in all things. Then his peace is like a river. He also is more prosperous in the lower or temporal things.

The celebrated teacher, Mark Hopkins, declared that one must always obey his conscience. Nevertheless, the conscience is not an infallible guide, for it often needs enlightening, and one is responsible for the right instruction of his conscience. Illumination from the Word of God, which is the only safe instructor of the conscience, and also the guidance of the Holy Spirit, are indispensable to the one who would live in the two worlds.

Brief Life

Mushrooms grow rapidly, reaching maturity in about six weeks. The life in the adult state is very brief. It rapidly falls into putridity and decay. Some grow up in a night, and at the close of the next day sink into decay. Here is a great contrast to the tree. The life of trees is marvelous. Abraham's oak at Hebron, and the olive trees in Gethsemane are examples, also the magnificent Sequoia gigantea of the Sierra Nevada, some of which are over 400 feet high, and 112 feet in circumference. They antedate the time of David. From its very nature a tree may go on growing and enlarging itself for ages, and after thousands of years still be in full vigour of its strength.

He who lives only the lower life, or that according to his flesh, will find life very brief, like a hand's breadth, even as a vapour to vanish before the rising sun. And although he may have the wealth of a Crœsus, the erudition of a Solomon, and the prowess of a Samson, life will be unsatisfactory. All will prove unsatisfying to him, with the prospect ever before him that very soon he must say farewell to them all. Sad and insufficient indeed, is the life of the one who has no bright prospect before him, but only insolvency in all those things for which he has lived.

But he who partakes of the Divine nature, has everlasting life. He is like a tree planted by the rivers of water. "His leaf also shall not wither." And as his outward man fails, the inward man is being renewed day by day.

Questions for Review

1. To what species do mushrooms belong? Can they live on the food on which lichens subsist?
2. How long has man used mushrooms for food?
3. What about the danger in gathering those which grow wild?
4. In the natural uncultivated state, where do they grow?
5. Describe how they may be distinguished from poisonous varieties of fungi.
6. How do the dangerous varieties of fungi often appear?
7. As vegetable meat, what do mushrooms contain?
8. How many varieties are there in the state of New York?
9. What is the botanical name of the edible variety? What name is erroneously given to other species?
10. Where are mushrooms cultivated in large quantities?

11. Where are such beds generally located?

12. Explain the process of cultivation. How extensive are such beds? What as to the size of cultivated mushrooms?

13. What food is largely made of mushrooms?

14. To what group of organisms do mushrooms belong?

15. What are the results of the presence of such organisms in the affairs of our life? Give examples.

16. As to their habits, what are they?

17. How are they propagated? On what things may they locate, and do their work? Give examples.

18. What, in our gardens, are subject to their attacks?

19. What is the life substance in them called? How do they differ from a daisy?

20. How do they obtain their food? What name is given such plants?

21. Why are they said to live in the slums of the vegetable world? What are the two varieties of such plants called?

22. How do trees differ from fungi?

23. The distinction between trees and the fungi is suggestive of what Bible teaching?

24. How can one live in the realm above him, as taught by Drummond?

25. What was Jesus' teaching concerning this, and what did He term the change into the higher realm?

26. How do fungi reproduce their life? Explain fully.

27. In how many worlds do fungi live? From what source alone do they gain their sustenance? How is it with trees?

28. What is the substance which makes plants green? In how many worlds do such plants live?

29. What is the ministry of the green skin in plants?

30. Explain the part which green plays in plant life. What does the possession of green colour enable plants to do?

31. What, then, does the presence of green in plants indicate?

32. What do other colours indicate?

33. What replaces the endochrome in fading leaves?

34. To what, in animals, is the green in plants likened?

35. What effect does light have on green leaves?

36. Explain how leaves fade in the autumn. Of what is red, in leaves, always an indication?

37. Why is it that trees may be said to live in two worlds?

38. Of what is this a suggestion in human lives?

39. In what way can men live in two worlds?

40. Explain the action of light on plants. Of what essential characteristic, in men, in this a suggestion?

41. What does Mark Hopkins say regarding obedience to one's conscience, and what does the conscience need?

42. What of the brevity of life in mushrooms? How is this in contrast with trees? Illustrate. What of a person who lives only in the lower life?

43. Of what nature may men partake which enables them to have everlasting life?

IX

THE MISTLETOE

ONE degree above the fungi in the vegetable realm, but still a parasite, is the mistletoe. It has not only interesting characteristics, but has also largely influenced mankind.

As " Father Time " swings around his circuit, bringing us the Christmas tide, our homes become decorated with the mistletoe. The soft hues of its evergreen leaves form a decided and pleasing contrast with the barrenness of winter in our northern latitude.

Legends

But it is not for that alone that its boughs deck our homes. It is rather because there lingers with us still a remnant of the old associations of that plant with the religious life of man. The ancient Norse legend concerning it is interesting.

Everything that was beautiful, eloquent, wise and good the Northmen believed was found in their god Balder. He was the spirit of activity, joy and light.

On the contrary Loki was the incarnation of evil, and envying the beauty and innocence of Balder, sought to effect his death. The myth giving account of this tragedy is as follows. Balder being tormented with dreams that his life was in peril, told them to the assembled gods who resolved to do all in their power to avert from him, and from them, such a dreadful calamity.

Frigga, his mother, the wife of Odin, exacted a

promise from fire and water, from iron and all other minerals, from stones, trees, animals, diseases and creeping things that they would on no account hurt Balder. From that time on he seemed to be immune from injury by anything.

To show him respect, as well as for their own pastime, the other gods assembled on the plains of Asgard, and spent their time in making Balder their mark; some hurling rocks at him, or thrusting at him with darts and spears, while others hewed at him with their battle-axes and swords. But do what they would, none of them could harm him.

This inflamed the Cain-like jealousy of Loki, and he transformed himself into a woman, and visited the palace of Frigga, who asked the pretended woman what the gods were doing at their meeting. "They are throwing darts and stones at Balder, without being able to hurt him."

"True," said Frigga, "for neither stones, nor sticks nor anything else can harm him, for I have secured an oath from all of them." "What," exclaimed the woman, "have all things sworn to spare Balder?" "Yes," said Frigga, "all things except one little shrub called the mistletoe, which grows on the eastern slope of Valhalla, but it is so small and feeble that I thought it not worth while to secure its oath."

Upon this Loki went away, and assuming his natural aspect, secured a bough of mistletoe, and repaired to the plains of Asgard. There he saw the blind god Hoder, who represents brute strength. He asked him why he was standing apart from the other gods, and not joining in the sports. Hoder said, "Because I am blind, and cannot see where Balder is, and besides I have nothing to throw."

"Come," said Loki, "do like the others, and show honour to Balder by throwing this tiny twig at him. I will direct your arm toward the place where he stands." Hoder took the mistletoe, and guided by Loki, threw it with such strength that it pierced the god through and through, and "thus fell Balder the god by the bough of the uncharmed mistletoe."

Upon his death all the gods gave vent to their grief by loud lamentations. As Longfellow sings:

"I heard a voice that cried,
'Balder the Beautiful,
Is dead! Is dead!'
And through the misty air
Passed like the mournful cry
Of sun-ward sailing cranes."

Doubtless it is due to this legend that the mistletoe owes its sacred character which it has borne ever since.

Among the Germans, as well as among the Scandinavians, this plant played an important part, and it is still used in Normandy when wishing a happy New Year. The ancient Britons esteemed it with great reverence. Traces of the ancient regard for it still remain in the old English and German customs, which have also been transplanted to America, where they flourish as vigorously as in the native soil.

The Druids, priestly class among the Gauls, Germans and Britons, sought for the mistletoe for their new year's day festival, held on the sixth day of the moon, as near to the 10th of March as the age of the moon would allow. If it were discovered growing upon an oak, its presence was hailed with delight. It was believed to have been sent from heaven, and to be possessed with magical virtues.

Two white oxes, for the first time placed under the yoke, were driven to the oak tree, by the high Druid dressed in his white garments. Here the mistletoe was cut with a golden sickle, and was reverently caught in its fall in a white cloth.

Forthwith the oxen were slain and offered in sacrifice to the god under the tree chosen of him upon which to deposit that heaven-born plant.

Amid the prayers and hymns of the worshippers, the mistletoe was broken into bits, and distributed to the people as a relic for the new year, a remedy against poisons, a heal-all for diseases and a talisman against witchcraft and evil spirits.

Botanical Name

The Latin botanical name of mistletoe is viscum album. It forms an evergreen bush about four feet high, and is thickly studded with branches dividing into pairs, termed dichotomous, and opposite leaves, which are of a soft green hue. Its flowers are diœcious. Its one-seeded berries are about the size of currants, white, and filled with a viscous transparent pulp. Bird-lime, a sticky substance smeared on twigs to catch young birds, is made from the berries, and from its bark.

There are over four hundred species of the plant. It is a native of a greater part of Europe, and grows in America. That which is so extensively used in England and the United States at Christmas tide is largely derived from the orchards of Normandy.

A Parasite

It is a parasitic plant. That is, instead of growing up out of the earth, and drawing its life from the soil,

and from the gases of the atmosphere, and being its own support, as is the apple tree, it obtains its lodging and board also, from trees. It grows upon many trees, particularly the apple, pear, hawthorne, and sometimes upon the sycamore, lime, poplar, locust and fir, but seldom on the oak.

Its berries are a favourite food for the thrush, and for most other frugivorous birds. It is through their agency that it is propagated. The sticky substance surrounding the seed, causes the seed to adhere to the beak of the bird, and when he alights upon a tree, and wipes his bill upon the bark, the seed clings to the tree. If it fell to the earth it would perish, but upon the bark of the tree it is at home.

"On the apple tree's bark it is in clover. It has found its haven, and now makes the most of its chance. Germination of the seed is soon set up, and then the radicle, which is simply the youthful root, penetrates the bark of the tree, and seeks out a special layer of the stem of its host. This is the layer, near the bark, through which the sap ascends." [1]

When the seed germinates, it displays an instinct akin to reason, in that the radicle always turns toward the branch, whether the seed is on the upper or on the under side.

As it advances in growth it sends out numerous rootlets, or haustoria, which penetrate the bark, where their cells become woody or lignified; and thus its connection with the wood-cells of its host become most intimate, while it derives its nourishment from the living tissue of the tree on which it grows, and from which it soon seems to spring as if it were one of its own branches, instead of being the stranger that it is,

[1] "Glimpses of Nature," Andrew Wilson.

so wonderfully is it grafted in among them, and with them made a partaker of the root and fatness of the tree.

The fluid of the tree which forms the food supply for the mistletoe is termed "crude sap." That is, it is the sap which is on its way from the roots to the leaves, where it is to become perfected; for once there it soon acquires all the properties which fit it to become nourishing food for plant life.

The growth of the mistletoe is slow, and its durability is proportionately great, its death being usually determined by that of its host, of which it has become a part.

By botanists, and natural historians the mistletoe is a much despised plant. It belongs to an ignoble family, the parasites. Professor Henry Drummond says: "Parasites are the paupers of Nature. They are forms of life which will not take the trouble to find their own food, but borrow or steal it from the more industrious." [1]

Andrew Wilson referring to our old friend, the mistletoe, says, "There is no nobility in the character of animal or plant which attaches itself to another living thing, either as lodger or boarder, or in the double capacity of an unbidden guest. Like dissatisfied tenants nowadays, it insists on holding to its landlord, while it declines to pay rent in any shape or form." [2]

I must confess to a good deal of sympathy for this poor plant which has been so assailed, because of its weakness, and its utter lack of character.

Good and wise men have combined against it, and their skill is directed toward its defamation. Their

[1] "Natural Law in the Spiritual World," p. 317.
[2] "Glimpses of Nature."

words against it have been a sharper blade than that of the golden sickle in the hand of the ancient high Druid. They declare that it has fallen from its once distinguished and dignified position of independent self-support; that it is sinking lower and lower in the scale of life. And the prophecy that ultimately it will become so degraded that its beauty will fade from it, and at some far-off Yuletide, no green leaf will grace its withered branches, and it will be an object fit only for the finger of scorn, or contemptuous neglect.

It may not be a very energetic plant, but we are bound to admit that, considering its many foes, it has done remarkably well to live so long in the world. In some remote age of antiquity it may have been subjected to a strong temptation, and like the first parents of the human race, may have fallen from its lofty estate. And whatever may have been its capabilities prior to that calamity, it is wise enough now to know that it would soon perish if it pleased its critics, and sought to root itself in the earth, and so at the risk of forfeiting their admiration, it seeks a home where it knows it will be safe, and can thrive.

Human Parasites

Let us not forget that the best, and most independent of us were for a long time in our infancy, nothing but parasites, drawing all our life from those whom we were unable to compensate; and that later in life, calamities frequently overtake us which render us incapable of self-support, and so we become dependent upon the industry of others.

There was a deep truth underlying the regard of the Druids for the mistletoe. Living upon the oak, from which it drew its sustenance, they saw in it a

representation of man dependent entirely upon God, and yet with an individual existence of his own.

Like the mistletoe, we cannot take root in the earth and live. There we are out of our native element, and can find nothing with which to nourish our spirit. Many before us have sought to thrive there and have failed, and many more are making the same effort only to be disappointed in the end, and just as some seeds of the mistletoe continue to fall to the earth where they are certain to perish, so these poor humans are doomed to defeat. God is our native soil, and we must take root in Him or perish.

We have seen that on whatever side of the limb of a tree the seed of the mistletoe finds lodgment, when it germinates, its radicle will not reach for the earth, or for any other object, but turns toward the limb, that it may hide itself within its bark.

The tendrils of our soul are ever reaching out for something to satisfy the craving within. They fasten upon numerous unsatisfying objects, where they are inclined to become permanently attached, to our irreparable loss. Blessed are we if the radicle of our heart, moved by the divine impulse from within, turns constantly toward Christ, in whom we abide as branches in the parent vine.

The most unsparing critics of the mistletoe must admit that it possesses some redeeming qualities. Its blossoms add beauty to the tree upon which it thrives, as the beauty of the Lord our God is upon us, if we abide in Him. "I have created him for my glory."

The evergreen leaves of the mistletoe also form a decided and pleasing contrast with the desolation of winter which are upon every hand. The one who is in vital contact with Christ, may be in the midst of

spiritual barrenness, and yet his leaf shall not wither. Age does not make him sear, and repellent, but he retains all the attractions and beauty of character as if he had perpetual youth; for the rootlets of spiritual nature drink from the river of the water of life, by the side of which he is planted.

A Worker

Another saving clause in the botanical character of the mistletoe is the fact that it works out its own salvation as the crude sap is taken in. The sap thus absorbed being in the crude rather than in the perfected state, indicates that the plant performs work in assimilating it to its own peculiar needs. The green of its leaves also testifies that it inhales carbonic acid gas from the air, through the innumerable stomata, or mouths, in the leaves, and at the expense of tremendous energy, rends asunder the carbon from the oxygen, retaining the former to build up its woody fibre, while exhaling the oxygen which is indispensable in all animal life.

Our spiritual food never comes to us fully completed, and predigested. We must work out our salvation, as God works in us, by assimilating the truth to our own peculiar needs.

The mistletoe is termed a "pauper of nature," because it is a parasite, and we are told that the naturalist despises parasites as the most ignoble creatures in nature, because "parasitism is one of the great crimes in nature. It is a breach of the law of evolution." [1]

People who live in glass houses should not throw stones. He that is without sin among us, let him cast the first stone at the poor mistletoe. Has it made a

[1] "Natural Law," Drummond, p. 319.

breach in the law of evolution? So have we. Has it fallen into a degraded state, from what it once occupied? So have we. "I planted thee a noble vine, wholly a right seed; how then hast thou turned into the degenerate plant of a strange vine unto me?" is the charge which God makes against Israel, and it applies as truly to each one of us who has sinned. How far short have we come in evolving a character like Christ's! We seem to be no nearer it than was John, the beloved disciple, or Elijah or Enoch. Truly we have made many breaches in the law of spiritual evolution; and the little mistletoe resting quietly upon the oak, declares to us that we shall attain to perfection not by a process of evolution, but by following the example of that humble plant, and becoming a pauper in grace as it is a pauper in nature.

Such is precisely the attitude which one must take ere he is willing to come to Christ. "Nothing in my hands I bring, simply to Thy cross I cling." He came not to call the righteous, but sinners. "They that are whole have no need of a physician, but they that are sick."

God has chosen the despised things of earth to be His greatest ministers. The mistletoe upon the oak is a symbol of what our relation must be toward Christ. Rooted in Him; for, severed from Him we can do nothing. Like as the life of the tree becomes the measure of the life of the mistletoe, so the eternal life of Christ becomes the measure of the life of those who abide in Him. They shall never die.

Parasites are despised because they lose their own powers, and become increasingly dependent upon their host. Yet this is the highest law of grace, as we see expressed in the life of Jesus. He was absolutely

dependent upon the will of the Father, and yet no one was ever so free as He. His life teaches us that the truest freedom, and the highest dignity, are not incompatible with complete dependence upon God.

Questions for Review

1. Why do we decorate our homes at Christmas tide with the mistletoe?
2. What were the various Norse legends concerning this interesting plant?
3. Who were the gods Balder and Loki?
4. Whose wife was Frigga?
5. What sport did the gods engage in, and where?
6. What proved the undoing of Balder? How was it wrought?
7. What are Longfellow's words concerning this?
8. Among what peoples has the mistletoe exerted a potent influence?
9. How did the Druids regard it? Who were they? Illustrate.
10. What is its botanical name? Describe the plant.
11. What are made from its berries and bark?
12. How many varieties of such plants are there, and in what countries do they grow?
13. Where, and on what does the plant grow?
14. By what means is it propagated?
15. Describe the manner of its seeds finding lodgment, and of their growth.
16. In this process, what seems like an instinct akin to reason?
17. How does it become connected with its host?
18. What becomes its food supply?
19. What as to its growth, and durability?
20. What does Drummond say of parasites?
21. What does Andrew Wilson say about them?
22. Why can we have some sympathy for such a plant?

23. What is the prophecy concerning this plant?
24. What may have been its original condition?
25. What about human parasites?
26. What deep truth underlies the Druids' regard for the mistletoe?
27. In what respects are we like the mistletoe?
28. In which direction will the radicle of the seed of the mistletoe always turn?
29. How does this apply to us?
30. What are some of the redeeming qualities of the mistletoe?
31. What does this suggest regarding our vital contact with Christ?
32. In what important ways is the mistletoe a worker?
33. What does this suggest regarding our spiritual food?
34. What is termed a breach of the law of evolution?
35. Does this apply to us; if so, how?
36. How must one imitate the mistletoe, if he would thrive in the spiritual realm?
37. In the religious sense, how does parasitism apply to us?

X

GRAFTING

INFERIOR and undesirable plants and trees may be improved, or changed entirely, by a process of budding or grafting. As the results are identical, we will consider only grafting, as illustrative of all methods, in this nature study.

All trees which are known as "natural fruit" trees have very inferior fruit. It is generally small, acrid, and gnarled, and is not good to the taste. Fruit from such trees is not likely to have a demand for it in the markets, and so the trees producing it are not highly esteemed. There are some exceptions regarding what is termed natural fruit, but these are quite unusual.

All such trees are those which result from seeds which have been scattered in various natural and haphazard ways, and found lodgment in the soil, and sprang up, or were planted.

Quite often land which has been used as pasturage, and is more or less neglected, may come to have large numbers of such wild apple, or pear, trees.

These generally grow in clusters, and are of a scrubby nature, and are entirely neglected, being regarded as worthless. Because of a lack of cultivation of the trees, and of deterioration through inherited qualities, their fruit is small and neglected.

But such trees may be rescued from their debased condition, and restored to the honoured family of fruit trees, by grafting them.

All Good Trees Are Grafted Ones

Fruit trees seem to be quite an exception in the vegetable realm, in that the children, as with us humans, do not necessarily partake of all the fine qualities of their parents.

Wheat, or oats, and other grain, will produce from the seed the same characteristics which are in the grain which is sown. This is so true that grain of the most excellent varieties is sought as seed for wheat, or other grain, that the same may be reaped in the harvest.

But plant the seed of an apple tree bearing choice fruit, and you do not know what you will have in the new tree which develops from that seed.

And hence all good fruit trees are those which have been grafted.

The author remembers to have aided an uncle, in his boyhood days, in planting long rows of apple-cores containing seeds. These sprang up, and the next season, slender shoots were seen, and in due time these were set out into rows over a field, to form an apple orchard.

But every tree had to be grafted. Various kinds of highly valued, and cultivated fruit trees were used for the grafts, or scions, as they are termed.

As the result of this grafting, a fine large orchard was secured which bore precisely the variety of fruit which was desired.

Very wonderful changes are wrought in trees by grafting processes. By a careful selection of scions from the trees bearing the largest and finest fruit, the superior qualities of the fruit from those trees may not only be perpetuated, but the fruit may be decidedly improved.

The Method of Grafting

There are numerous varieties of grafting processes, sixteen or more, having as many names, such as the crown, groove, rind, saddle, side, split, slice, tongue, and so on, but they all are essentially the same.

The one requisite is to have the graft, or scion, to correctly fit into the tree or branch into which it is inserted. A single illustration of the process will suffice.

In what is called the cleft method, the tree, or branch, called the stock, is sawed off square, and is split downward, and a wedge-shaped scion, taken from a tree bearing the desired kind of fruit, is inserted into the split opening. If the stock is larger than the inserted scion, as is often the case, then two twigs, each having one or more buds on it, are thrust snuggly down into the opening of the stock, which has been held open by a wedge. Care is taken to have the inner bark of both the scions and the stock to be in intimate contact.

This inner bark is known as cambium bark, which is a meristematic, or tissue forming, zone of cells which lies between the wood and the bark. It is this cambium layer of cells which produces the growth of the tree. This layer hardly seems like bark at all, it is so soft. It is sometimes called " downward sap."

It is found in all exogenous plants, which are trees having bark, wood, possibly pith, and the growth of which is on the outside, under the bark; and so they are termed outside growers.

The cells of the scion and those of the stock coming into contact, partake of the sap, and continue to grow without any difficulty.

It is necessary, however, that the air be excluded from these delicate cells, and so some soft material is placed over the top of the stock, and closely around the scions, and down along the split which was made in the stock.

This air excluding material is usually made of a combination of bees-wax, tallow, and rosin melted together, and made into a pliable material which is easily applied, and is sticky, so that it will not peel off.

Sometimes clay is used for wrapping around the grafted parts. Even a cloth saturated with tar may be employed, but the bees-wax is generally regarded as better.

A Changed Tree

After two or three years a great change is observed in the grafted tree. The new grafts partake of the sap and vitality of the tree, and grow rapidly, and in due season, blossoms and fruit appear on them, but they are decidedly different from those on the original tree.

Two kinds of fruit may be seen growing upon the same tree, but what a contrast between the large, fair, highly cultivated fruit on the grafts, and the small gnarled kind on the natural branches.

Pruning Off the Old

Gradually these natural branches are pruned off the tree, as rapidly as the tree can bear the hurt of the pruning knife, without being too greatly retarded in its growth.

After the final pruning a new and valuable tree results from the scrubby, worthless one, all because

new life has been inserted into it in the process of grafting.

It seems strange that such a tiny thing as a twig, or scion from a healthy, high class tree, could make such a great difference in a worthless tree, by being engrafted into it.

The Value of Early Grafting

Nurserymen, and horticultors generally, have learned the importance of the early grafting of a tree. Instead of waiting until it is fully grown, or even partially developed, with many branches, and then being obliged to cut off several branches in grafting, and later lopping off the old limbs, and wounding the tree thereby, they cut the body of the tree across when it is very young, and by inserting one or two scions, change the whole nature of the young tree by that single process.

This saves time in securing good fruit from the tree, and also it saves labour, and does away with the necessity of hurting the tree later, by pruning off the worthless branches, which bear only undesirable fruit. Generally one can find the enlarged ring around the young tree, close to the earth, where the grafting process was performed.

After a time, even this disappears, and nothing about the tree would ever indicate that it is a grafted one. It has gone through the experience which all good fruit trees must pass, if they would be given good care because of being highly esteemed for their fine fruit.

A New Tree and a New Life

On the completion of the grafting, there is a new tree, because there has been introduced into it a new life. It is worthy of notice that the changes wrought by

the process of grafting in trees, are so similar to those which occur in human lives, that grafting is an apt illustration of what may occur in our own lives.

We grow up very much like the wild, natural fruit trees. Father, or mother, possibly both, were very religious. The fruit of their lives was beautiful. We have in us the germ transmitted to us from them. The seed unfolds, it is true, but it does not seem to have the piety, and love for spiritual things which were in them.

Physically and mentally we resemble them, but not spiritually. Our fruit is gnarled, and unattractive: it is the product of a natural fruit tree. The spiritual life which was in them has not been inherited by us.

What is the difficulty? We do not love to pray as they did; we do not dwell upon religious things as they did; nor do we love the place of prayer, or to peruse the sacred Scriptures. Why is it?

The spiritual life was engrafted into them, and was not inherited from their ancestors, neither can ours be. We ourselves must receive the new spiritual nature, grafted into us.

James, in his epistle, chapter 1: 21, says, "Receive with meekness the engrafted word which is able to save your souls." And that word of God is living and powerful, and by means of it, we become "partakers of the divine nature."

That nature, imparted to the human spirit, bears new fruit, as truly as does the scion which has been engrafted into a natural tree.

This is God's way of changing the human spirit, from nature to grace, from death to life, by having His own nature engrafted into it. And we need to remember that early life is the best time for this graft-

ing process to occur, as we have seen that it is with young trees.

When the older trees are grafted, there are many branches on it which are the product of the old natural tree, and these, if left, will bear the undesirable fruit, and so those branches must be cut off, lest the energy of the tree go into them to the detriment of the new grafts, and the new fruit. And this pruning process always means a wounding, more or less, of the tree, and hence it cannot be done too severely, or too many at a time.

In the lives of mature men and women there are many undesirable habits, and notions, which are the fruit of the old natural life. These, after the new divine nature is received, grafted into them, have to be pruned away, and it is more or less a painful process for one to rid himself of these entrenched habits, and opinions, and growth is retarded, often seriously hindered by them.

And also two kinds of fruit are found in such lives, the good, along with the very opposite—like the full grown tree, which has new grafts with new fruit upon them, and also many branches from the old stock which are bearing gnarled and worthless fruit. Two opposite kinds of fruit are on the same tree.

The old limbs must be lopped off. Sometimes that may be neglected in a tree, and all its life it presents the spectacle of bearing two kinds of fruit, but that is most undesirable, and wholly unnecessary.

It is like one being under the rule of the old habits, after he has received the new divine nature. He needs pruning. The old branches should be lopped off.

But in young lives, before evil practices have grown into bad habits, such severe pruning is unnecessary

after having had God's nature grafted into them. Like very young trees, which are cut across the body near the earth, and grafted, and no branches are left, on which natural fruit can grow, and there is no wounding process necessary in pruning later, so in the very young, who become Christians, through the reception of the divine nature, which means the indwelling of the Holy Spirit, there is no such struggle with the old nature, which is forever cropping out, to be painfully cut away.

Hence there is no such favourable and delightful time in which to receive Christ into one's heart, and become a Christian, or to be engrafted with God's nature, as in the days of youth.

"Remember now thy Creator in the days of thy youth, while the evil days come not."

Questions for Review

1. What sort of fruit is produced by "natural" fruit trees?
2. What are "natural" fruit trees?
3. How do they generally originate?
4. What is their usual manner of growth and appearance?
5. How are fruit trees an exception in the vegetable realm? Give examples.
6. Can we depend on the kind of a fruit tree which will develop from planted seeds? Illustrate.
7. To be certain of securing a definite kind of fruit, what must be done?
8. How many processes of grafting are there?
9. What is the requisite in any form of grafting?
10. What is the cleft method? Describe it.
11. What is the inner bark called? What does this bark do for the tree? What is it sometimes called?

12. In what kind of plants is this found?

13. What is the inserted graft called? Into what is this inserted?

14. What must be excluded in the process of grafting? How is this done?

15. What kind of scions are sought for in grafting?

16. What is the result of grafting on the engrafted tree?

17. If left to themselves, how many kinds of fruit will such trees bear?

18. What must be done with the natural branches?

19. What caution must be used in pruning after grafting?

20. At what age of the trees do nurserymen usually do the grafting? Why is this?

21. What is the advantage in such grafting?

22. What is the final result of grafting and pruning?

23. How does this apply to our lives?

24. Are spiritual characteristics always inherited by children from their parents?

25. Why are not the religious habits and practices of parents inherited by their children?

26. Where did our parents obtain their love of religious things?

27. What does the Apostle James say which throws light on this subject?

28. What is God's method of changing our lives?

29. What must finally be done with all the old natural branches on a grafted tree?

30. How does this apply to our lives?

31. How many kinds of fruit may sometimes be found in one's life? Why is this?

32. How are conversions late in life like the grafting of old trees? What is likely to occur?

33. At what age, then, is the best time for one to receive the divine nature? In reality, what in us is this grafting process?

XI

BLOOD

FROM the highest form of vegetable life, as the tree and its cultivation and transformations until the most valuable fruits are secured, to the life which is manifest in the animal kingdom, is a marked upward step in the realm of nature. True, it is a thin line which separates the highest vegetable from the lowest animal, and they are not infrequently mistaken the one for the other, and have been the cause of heated controversies.

New Powers and Possibilities

But once step from the vegetable into the animal realm, and you meet with powers and possibilities for development which vastly transcend anything in the kingdom which you have left behind.

Every creature, however, is anchored in the lower realm, as its base of supplies, and possesses the mysterious power of incorporating and transforming it into animal cells, tissues and energy.

What the vegetable does in transforming the mineral, upon which it subsists, that the animal does with the vegetable. It goes further and finds its ancestral roots running down into and through the vegetable into the mineral kingdom.

And so all animals are closely related to that which is below them; for out of the dust they sprang, and sooner or later to it they must return. Nevertheless they are in a new and higher world.

Similarities with Vast Differences

And yet the differences between the animals are most marked, and seemingly, they are so vastly separated one from another that it is a very long way from the lowest to the highest; as great a distance as any which lies between them and the kingdom below them.

Notwithstanding this, they possess mysterious properties which the highest and lowest share in common. And, in this nature study, we shall consider one of these, which is blood.

"The Life of the Flesh is the Blood"

Every one is familiar with blood; even children see it, and know something about it, and yet very few stop to consider it, or ever learn how very wonderful, and mysterious a thing it is.

Every intelligent person knows that it is a red liquid which flows in our veins, and that at certain times, when the body is injured, it flows out of the wound, and that its loss is dangerous, and that we cannot live without blood.

The blood is not only absolutely essential to all living beings, but is so mysterious and wonderful in what it is and does, and it teaches us such valuable lessons, that it is well worth our knowing more about it.

A Living Liquid

Blood is an alkaline fluid, consisting of water, of solid and gaseous matters. In 100 parts of blood, seventy-nine parts are water, and twenty-one parts solids; the same proportions as nitrogen and oxygen are in the air. The gaseous portions of the blood are carbonic acid, oxygen and nitrogen; about two-thirds

carbonic acid, less than one-third oxygen, and one-tenth nitrogen.

The Red Corpuscles

But the blood is also a living liquid. It has both red and colourless corpuscles which are living bodies. The red corpuscles are flat, round bodies, or biconcave disks, on the average 1-3200th of an inch in diameter, and about one-fourth as thick. They are soft, flexible and elastic, so that they can squeeze through apertures and spaces much narrower than their own diameter, and then immediately resume their former shape.

Some believe that the red corpuscles are formed from the colourless ones; or that possibly they are the nucleus of the white corpuscles. Other physiologists state that they are made in the red marrow of the bones.

According to Huxley there are seventy million red corpuscles in a cubic inch. Then, in a man weighing 135 pounds there are twenty-one trillion such corpuscles, and in one weighing 156 pounds there are twenty-three trillions. Thus, in numbers, the body becomes a symbol of the starry heavens. It is like the Milky Way and the Island Universes in the Nebulæ, while a corpuscle is like a solar system.

The red corpuscles make up about one-half of the total volume of the blood. When looked at through a good microscope they present a most interesting sight. They roll over one another, much as do boys in playing leap-frog, and are in incessant motion as long as they live. Gradually they slow down their activity, and are motionless in death.

After one has drawn a drop of blood from his finger, and placed it on a thin glass, and viewed it through a

microscope, and seen the strange living entities which it contains, he can never forget that his blood is filled with a wonderful kind of life.

The function of the red corpuscles seems to be to load themselves up with oxygen, and to impart it to the surrounding media wherever oxygen is there present in less amounts than that which is carried by the corpuscles.

Besides carrying oxygen to the different parts of the body, to bring about oxidization, the red corpuscles take upon themselves the carbonic acid, which results from the tearing down, or burning and wearing out of the tissues, and other portions of the body. They remove the carbon dioxide to the lungs. The presence of this gas causes them to swell out, while the oxygen received in the lungs flattens them. The oxygen changes their colour from a dull red to a bright scarlet.

It will be seen that they are incessant toilers of a most benevolent nature. They have the characteristics of their Creator and ours, and of all who partake of His spirit of beneficence. They stoop down and toil to bless those in need.

The Colourless Corpuscles

These are no less interesting and important than the red corpuscles, although much less numerous. They usually number one to every three hundred of the red ones, but are larger, being on the average 1-2500th of an inch in diameter. They are irregular in form, and unceasingly change their shape, as the result of changes taking place within them.

They are spheroidal bags, or sacks, with very thin walls, having a clear granular fluid within them, and a spheroidal vesicular body, called the nucleus.

It is thought that they are parts of the solid substances of the body, which have been detached, and carried into the blood.

All invertebrate animals, and the embryo of all vertebrate animals, have only these colourless corpuscles, while all mammals have two kinds, like man.

These colourless corpuscles have the power of self-movement, for they are found not only inside but outside of the blood vessels, showing that they work their way between the cells forming the walls of the blood vessels.

Vicarious Sacrifice

Wherever there is irritation or pain in any part of the body, these white corpuscles rush to that portion, ready to do battle with the enemies which caused the trouble.

The value of the mustard plaster depends upon this. It causes the action of the white corpuscles, although it was not known until recent years just what caused the relief received from such counter irritants, as they were termed.

They really produce phagocytosis, or the destruction and absorption of bacteria or microbes by the phagocytes, or white blood corpuscles.

The famous Russian bacteriologist, Elie Metchnikoff says: " The leucocytes, or white blood corpuscles, appear to have the power of destroying bacteria in certain cases. If the bacilli of the anthrax are inoculated in the frog, the white blood cells are seen to incorporate and destroy them, until they entirely disappear, and the animal is not affected. If, however, the animal is kept at a high temperature after inoculation, the bacilli increase so rapidly that they gain the upper

hand over the leucocytes, and the animal sickens and succumbs.

" The leucocytes, then, may be regarded as a soldier-like community, one of whose special offices is to fight to the death the invading hordes of pathogenic microbes." Hence Metchnikoff's expressive term, " the battle of the devouring cells against the cause of disease.

" They have the power of pushing out and withdrawing portions of their bodies. Into the retracted portion of one of these phagocytes a microbe is received. It is finally enveloped and disappears by absorption or digestion.

" These corpuscles take upon themselves the burden of ridding the body of its bacterial enemies, and if need be, of suffering death to accomplish this purpose; it has been proven that the injection of bacterial products into the circulation may destroy the phagocytes." [1]

These are a very wonderful type of the vicarious sacrifice of Christ. He fought the battle for humanity. The Scriptures teach us that Christ died for us all. He was wounded for our transgressions. Having created the leucocytes, along with all other things, He certainly knew how fittingly they would typify Himself, and what He would do for us; and when we discover these facts concerning them, we think His thoughts after Him.

Blood Clots

A wonderful provision to preserve life is seen in the fact that when a wound is made in the body, and the blood comes into contact with the air, or is allowed to stand, it forms a clot, that is, a thick coagulated

[1] " Through Science to God," the Author, p. 93.

mass, and this quickly stops the flow of blood. Were it not for this mysterious characteristic of the blood, the least wound would cause us to bleed to death.

This leads to the fact that besides the red and white corpuscles, and the gasses in the blood, there are also other very important things.

The straw coloured liquid, which separates from the clot, is called serum, which is 90% water, 8% protein, and 1% other organic foods.

In the normal state of the blood, the liquid in which the corpuscles float is called the plasma. This is made up of a fluid portion of serum, and fibrin, which, while in the body is in a fluid state, but when removed from the blood vessels, coagulates, forming a clot, which is simply a mass of fibrin, thread-like processes, with a large number of blood corpuscles tangled within it.

Outside of the arteries and veins, in the spaces between the cells which form the tissues, is found another fluid, which is very much chemically like plasma of the blood. This is the lymph. It is fluid food in which some corpuscles are found. It acts as the medium of exchange between the blood proper and the cells in the tissues. The lymph not only gives food to the cells, but it passes oxygen to the cells in which oxidation takes place, and also takes away carbon dioxide, and other waste materials, which are ultimately passed out of the body by means of the lungs, kidneys and skin.

The Mission of the Blood

The almost constant temperature of the body at nearly 100 degrees is due to the blood, which brings to the surface of the body much of the heat given off by oxidation of the food in the muscles, and other tissues.

When the blood returns from the tissues wherein it has been oxidized, the plasma brings back with it to the lungs the carbon dioxide liberated by the chemical processes of oxidation which have taken place.

The blood carries to each part of the body the substances which that part of the body needs for its upbuilding and sustenance. To the bones it takes phosphate of lime; to the muscles phosphate of magnesia and phosphate of potash; to the cartilages soda; to the teeth fluorin; to the hair, skin and nails silicea; to the eye and hair iron, and to the brain phosphorus. It is a constant giver, but a receiver as well.

There is remarkable coöperation between the body and the blood. The chief work of the digestive tract is to change the food into blood. And the chief function of the blood is to supply nourishment to, and take away waste material from all parts of the body.

Contact With the Blood a Necessity

It is absolutely essential to the life of the body that it should be in such intimate relation with the current of blood, that matters can pass from the blood freely to it, and from it to the blood, by transudation through the walls of the vessels in which the blood flows. And this vivifying influence to the body depends upon the vital forces in the blood, or the corpuscles.

The following illustration given by Professor Huxley shows how important it is that every part of the body must be kept in intimate contact with the blood: "If the vessels of the limb of a living animal be tied in such a manner as to cut off the supply of blood from the limb, without affecting it in any other way, all the symptoms of death will set in. The limb will grow pale and cold, it will lose its sensibility, and volition

will no longer have power over it; it will stiffen, and eventually mortify and decompose.

"But, even when the death stiffening has begun to set in, if the ligatures be removed, and the blood be allowed to flow into the limb, the stiffening speedily ceases, the temperature of the part rises, and the sensibility of the skin returns, the will regains power over the muscles, and in short, the part returns to its normal condition." It has been proven that it is the corpuscles which impart the life to the body.

Blood is Sacred

In the Bible, the blood is regarded as peculiarly sacred. It is mentioned about four hundred and forty times: 330 in the Old Testament, and over a hundred times in the New Testament.

In the Old Testament it is stated that the life is in the blood, and that long before, men were aware that there were living entities in it, like the corpuscles. And repeatedly men were forbidden in any way to eat the blood, as it is the life of the flesh.

It became very sacred to God, because He chose it to be a symbol of His covering man's sin, or blotting it out of His sight. From the characteristics in the blood, which science has revealed, and which we have only partially considered, we can understand why it should be chosen as a symbol of man's redemption, or buying him back from sin, and its dominion over him.

And so all through the Old Testament sacrificial system, the blood of animals was shed, the life poured out, as a sacrifice for sin, that man might be forgiven, his sin passed over, and he welcomed into the presence of God.

The blood became a protector from death, as when it was put upon the doors of the houses of the Israelites in Egypt, and shielded the whole household from death, when the angel went through the land, and slew the first born in every house not so protected by the blood.

That was the origin of the sacred festival of the Passover among the Israelites, when God passed over all who were protected by the blood.

In the New Testament, considerably more than one-half of the one hundred times in which blood is mentioned, it refers to the sacred symbol of the blood, or life of Christ yielded up that man may have the pardon of his sin, and purified from it, be welcomed into the presence and favour of God.

Jesus spoke of a new covenant between God and man, made by His blood, poured out life, and said that the reception of it is necessary to our life. " Except ye eat the flesh of the Son of man, and drink his blood, you have no life in you." No intelligent person would take that to mean that he must turn cannibal, and eat the body of Jesus as he would eat bread; and drink His blood as he would drink water. Men were repeatedly forbidden to eat the blood. It, of course, meant that He and His surrendered life as a sacrifice, must be received by each one as truly as he would receive and eat bread.

All our hope is tied up with His blood. Notice some of the statements in the New Testament concerning this. We are " purchased " by it; " justified from sin " by it; " redeemed through " it; have " peace through it "; must " have faith " in it; have " no remissions of sins " apart from it; are " cleansed by it "; " sanctified by it "; " made white by it "; " overcome by it "; and so it is " precious," above gold and silver, which com-

pared with it, are " corruptible," and so it must not be ignored, or trampled underfoot as a common thing, to our eternal loss.

Now we can see how God has not only given us a marvelous thing in our blood, but has made blood doubly important, by constituting it a holy symbol of what He does in Christ to save us.

As every part of the body must come into intimate contact with the blood, that it may have life imparted to it, so we must come into immediate contact with God in Christ, that we may live, not for a few short years of this life, but to have life indeed, or God's eternal life in us.

The picture of the condition of our souls, apart from the blood of Christ, is presented by the limb of the animal, from which the blood is kept from flowing through it; pale, cold, insensibility, unresponsive to the will, stiff, loss of power to move, and eventually mortification and death.

If any one feels that blood is not an elegant symbol for God to choose by which to represent the forgiveness of our sins, and our acceptance by Him, let him remember that blood itself is not an elegant thing, but it is a living and an essential thing to each one of us. And no other thing connected with us, and nothing found anywhere in creation, could possibly, from its nature, be such an apt and perfect symbol of what is so necessary to our spiritual nature as is blood. What it is to our body teaches us what the sacrifice of Christ may become, by our acceptance of it, to our spiritual nature. It imparts life to it, warms it, comforts it, feeds it, builds it up, strengthens it, and purifies and rids it of that which is poisonous and destructive. Only God knows all its benefits to us.

Faith in the Blood

The change which is wrought in men's lives because of their faith in the blood of Christ, as representing His surrendered life on the cross on their behalf, has been observed for many centuries.

The very best of men recognize its importance and necessity. At the funeral of a man who had been a railway engineer, and was killed in an accident, as we stood by the grave during the last religious rites, another old member of the Brotherhood of Locomotive Railway Engineers, came to the author who was officiating, and said softly: " Thank God, he was under the blood! " That was his comfort in that hour of separation from a dear friend.

In a meeting for the Jews in San Francisco, an old Hebrew arose, and in substance said: " My Jewish brethren, this is Passover week, how will you observe it?

" You will put away all leaven; you will eat the ' motsah ' [the unleavened wafers] and eat the roasted lamb. But you forget that you have everything but the blood.

" Jehovah did not say: ' When I see the leaven put away, I will pass over you.' Ah, my brethren, you can substitute nothing for the blood. You must have BLOOD.

" I was born in Palestine, studied the Law, and learned Hebrew. I was struck with the place the blood had in all the ceremonies outlined in the Law.

" Day and night, one verse rang in my ears. ' It is the blood that maketh atonement for the soul.'

" In my distress, I consulted the rabbis. They told me that the only spot on earth where we dare shed

the blood of sacrifice, in accordance with Deuteronomy 12, was in Jerusalem, but the temple was destroyed, and a Mohammedan mosque was reared in its place.

"I tried to be satisfied, but could not. Nothing else but blood could atone for the soul, and we dare not shed blood for atonement anywhere else than in the place the Lord has chosen. The thought filled me with terror.

"I consulted many wise rabbis. I had but one question: 'Where can I find the blood of atonement?' They did not help me.

"I was thirty years of age when I left Palestine, and went to Constantinople. Going down a narrow street, I saw a sign telling of a meeting for Jews.

"I went in, and sat near the door, and heard a man say: 'The blood of Jesus Christ His Son, cleanseth us from all sin.' I listened breathlessly. He told that God had given His Son, the Lamb of God, to die, and that all who trusted in His blood were forgiven all their iniquities. It was the suffering Messiah of the fifty-third of Isaiah.

"Ah, my brethren, I had found the blood of atonement at last. I trusted it, and now I love to read the New Testament, and to see how all the shadows of the law are fulfilled in Jesus. It is God's way, and it is the only means of salvation for either Jew or Gentile."

Blood Tells

There is something exceedingly mysterious in the blood; far more so than anything which we have said about its characteristics, and its benefits conferred upon us.

In creating us with blood, God gave us something which has the marvelous power of imparting life to

the body, but also to so react on our mind and spirit, by what we do and are, that shall cause us in a way to live on in the generations to come.

The blood is a highly complex product of all parts of the body. Many of its features are due to the corpuscles, but every part of the body pours something into it.

It has been likened to a river, the waters of which are given their characteristics by its source in the spring from which it gushes forth, and by the animals which swim in it; by the soil over which it flows; by the vegetables found in it; by the irrigation works supplied from it, and by the drain pipes which empty into it. All these give character to the water.

So everything in the body, through which this river of life flows, gives character to the blood. All that we do, or think, or determine; our choices, our dislikes, and the friends we choose, affect our blood; make it what it is now, and what it will do to injure or bless the generations yet unborn.

As an illustration of how the characteristics of one's blood, through heredity, may be transmitted to those who shall live in the future, is the story of a family which was related to the author by the late Rev. John Dooly, a Presbyterian clergyman who conducted a mission on the Bowery in New York City, in the '60's of the last century.

He knew the history of the family, and wrote an account of it at the time, but to spare the feelings of the members, some of whom were Christians, and highly respected, he gave them the pseudonym of Jukes. He called the mother Margaret.

She was a neglected waif in the streets of New York, and became a bad woman, with criminal tendencies.

She had children and grandchildren. Sixty per cent. of her descendents were either criminals, and served terms in prison, or were insane and were confined in asylums, or diseased and were cared for in hospitals, or were paupers and died in almshouses.

They caused the community no end of trouble, and expense, because of their diseases, crimes, and other misdeeds. This account given by Mr. Dooly attracted wide attention throughout the country, and in 1874, R. L. Dougdale investigated it, and found that in a period of seventy-five years the Jukes family cost society over one million dollars.

A Better Story

A much more encouraging story of how blood tells, in transmitting to others the noble characteristics of a person, is given in Davenport's "Heredity in Relation to Eugenics," as follows:

"In 1667 Elizabeth Tuttle, 'of strong will,' and of extreme intellectual vigour, married Richard Edwards of Hartford, Conn., a man of high repute, and great erudition. From their one son descended another son, Jonathan Edwards, a noted divine, the president of Princeton College. Of the descendents of Jonathan Edwards, much has been written; a brief catalogue must suffice: Jonathan Edwards, Jr., president of Union College; Timothy Dwight, president of Yale; Sereno Edwards Dwight, president of Hamilton College; Theodore Dwight Woolsey, for twenty-five years president of Yale; Sarah, wife of Tapping Reeve, founder of Litchfield Law School, herself no mean lawyer; Daniel Tyler, a general in the Civil War, and founder of the iron industries of North Alabama; Timothy Dwight, 2d, president of Yale from 1886 to 1899; Theodore

William Dwight, founder and for thirty-three years warden of Columbia Law School; Henrietta Frances, wife of Eli Whitney, inventor of the cotton gin, who, burning the midnight oil by the side of her ingenious husband, helped him to his enduring fame; Merrill Edwards Gates, president of the Boys' Academy, Albany, Rutgers College and Amherst College; Catherine Maria Sedgwick of graceful pen; Charles Sedgwick Minot, authority on biology and embryology in Harvard Medical School; Edith Kermit Carow, wife of Theodore Roosevelt; and Winston Churchill, the author of 'Coniston' and other well-known novels.

"Of the daughters of the same Elizabeth Tuttle distinguished descendents also came: Robert Treat Paine, signer of the Declaration of Independence; Chief Justice of the United States Morrison R. Waite; Ulysses S. Grant, and Grover Cleveland, presidents of the United States. These and many other prominent men and women can trace the characters which enabled them to occupy the positions of culture and learning they held, back to Elizabeth Tuttle."

The lesson then, which blood teaches us is that we have been endowed with a very marvelous power, which enables us to not only live, and to have it teach us to look to God for life eternal, but that we and our characteristics are to live in others. We shall either help them or hinder them. What are you putting into your blood stream?

Questions for Review

1. Is the line of separation between the vegetable and animal kingdoms an easily recognized one?
2. Is there a marked difference between the two?

3. What as to the differences between those existing in the animal realm?

4. In what do animals find their ancestral roots, and how far do they penetrate?

5. How do animals utilize the vegetables?

6. Despite their differences, what do animals share in common?

7. What kind of liquid is blood, and of what does it consist?

8. Is blood mechanical, or living?

9. Describe the red corpuscles, and their origin.

10. What does Huxley say as to their size?

11. Of what are they a fit symbol?

12. What portion of the blood do they constitute?

13. Viewed through a microscope, how do they appear? Whence their colour?

14. What are the tasks which are assigned them?

15. Describe the colourless corpuscles; their size, appearance and origin.

16. What kind of animals have only these?

17. What power do they possess?

18. By what name are they called?

19. What does Metchnikoff say as to their functions? To what does he liken them?

20. What do they do with our enemies, the poisonous microbes?

21. Of what is their sacrificial burden a type?

22. What are blood clots, and why are they a wonderful provision to preserve life?

23. What is in the blood beside the corpuscles?

24. What other fluid is in the blood, and of what is it a medium? What does it do?

25. What regulates the temperature of the body?

26. What does the blood do in the tissues?

27. What does it carry to various parts of the body? Specify.

28. What as to the coöperation between the body and the blood?

29. What is the chief work of the digestive tract, and of the blood?

30. Why is intimate contact of the body with the blood necessary?

31. What illustration of this does Huxley give?

32. What is it which imparts life to the body?

33. How is blood regarded in the Bible, and how many times is it mentioned there? What does it say is in the blood?

34. Why is blood sacred to God?

35. How was it used in the Old Testament times?

36. When was it made a protector of life?

37. What festival originated from this?

38. In most of the references in the New Testament, of what is it the symbol?

39. How did Christ refer to this? Give His words.

40. Were men forbidden to eat blood? What did He mean by saying that men must drink His blood?

41. How is our hope tied up with His blood? What are the New Testament statements concerning this?

42. How is the necessity of our contact with His blood illustrated?

43. Was blood chosen as a symbol for our salvation because of its elegance? Is blood itself elegant?

44. What does blood do for our body? Of what is that a symbol?

45. What is said regarding the necessity of faith in the blood? Illustrate by giving the two incidents which are mentioned.

46. Give an illustration of how blood tells, as mentioned by the Reverend John Dooly.

47. What is an interesting and better story as to how blood tells?

48. What is the general lesson which blood teaches us?

XII

BATS

IN our nature studies there are numerous specimens in the animal world, the investigation of which would prove interesting and profitable, such as the crustacea and fishes, ants and spiders, bees and birds.

Much has been written concerning all these, which has served to make them more or less familiar. There is one, however, the bat, which, while not a total stranger, is less well known, and possesses habits and peculiarities which make its investigation attractive and instructive.

Lovers of Darkness

Some years ago a friend of the author purchased a farm on which was a house that had been uninhabited for a number of years. When he and his family came to occupy it, they discovered that it was already tenanted by a large number of bats which had taken possession of the attic. Their squeaking and quarreling were a great annoyance to the family. All efforts to drive them out and exclude them were unavailing for several summers. The persistent creatures managed to find entrances through small openings under the eaves and elsewhere.

At last the owner, knowing that bats "love darkness rather than light," installed electric lights in the attic, and at early dawn, when the bats come for their accustomed lodging for the day, they found the place

brilliantly lighted, and this they could not endure, and so they migrated in a body to more congenial quarters.

The prophet Isaiah was evidently familiar with the habits of these night prowlers, as is indicated by the following statement: " In that day a man shall cast away his idols of silver, and his idols of gold, which they have made for him to worship, to the moles and the bats " (Isaiah 2: 20).

These words have long since come true. For many years in Egypt, idols carved from stone, and worshipped by the people at one time, and the mummies of animals once held in religious reverence, have been lying in the caverns and tombs which are occupied by bats.

Often thousands of these live in the chambers of the various pyramids, and among the ruins. They seem to delight in the gloom of sepulchres, which have become the repositories of idols and the remains of sacred animals.

An Old Race

Bats are a very old race, for their forms are found inbedded in the rocks. They belong to an order of animals which naturalists call chiroptera, that is from the two Greek words, meaning " hand winged." For a long time they were thought to be birds, but they are quadrupeds, having four feet as truly as a horse or a cow. There are over four hundred species of them.

Strange Bodies

Their bodies are small, usually not being over two or three inches long, but when their wings are extended, they are from tip to tip, from eight to fifteen inches.

Their forearm bone, the one extending from the elbow to the wrist, is long and slender. They have a most interesting hand. Their thumb is short, and has a long sharp nail, or claw. They have similar hooks, or claws, on their hind feet by which they hang suspended at night.

The metacarpes, or bones of the hand, which extend from the wrist to the finger bones, and the finger bones, or phalanges, are very long and wire-like. They are joined together by a very thin skin, or membrane, and this extends to the elbow, and down along the body to the heel, and from the thumb to the shoulder. This constitutes the wing. Since the bones of the hand form the larger part of the wing, we can better understand why they are called chiroptera, or " hand winged."

When they fly, the fingers are spread out, and when they rest, the wing closes as a fan shuts. They are the least terrestrial of all animals, because it is so difficult for them to walk. But when they do walk they hitch along on all fours, as does a dog or a cat, but much less easily. It hooks itself along by means of its thumbs, hooking first one claw into the ground and then the other, and so manages to drag itself along slowly and awkwardly.

It is hardly able to rise in flight from the ground, and so it has to climb to a little height, and then to let itself drop, and as it drops, it spreads its wings, and glides away quite like the first gliding aeroplanes.

Its method of climbing is very curious. It climbs with its tail upward, its head downward toward the ground, and using first the claws of one tiny foot and then the other.

When it sleeps it hangs with its head downward, hanging by the claws of its hind feet. There is a reason

for this. As it cannot spring up from the ground in flight, and needs to be suspended at some distance above the ground, so that it can spread its wings as it drops, it can best do this by hanging by its hind toe-nails.

There is another way in which the modern aeroplane has copied the bat. It has a kind of an air rudder, like the aeroplane, which enables it to steer itself in the air. The skin which stretches from the wings, is carried around the end of the body, and is supported there, partly by the hind legs, and partly by the bones of the tail. By tilting this rudder up or down, or turning it one way or the other it is able to instantly alter its course at will.

Bats drink on the wing. Here again man's modern ingenuity has copied this little creature. Often railway engines take water by scooping it up from a trough by the side of the tracks while they speed along. The bat dips its lower jaw into the water as it skims along close to the water of a stream or pond.

They love to frequent pools and streams, not only for the sake of drinking, but for the insects which hover about such places.

How They Live

They live on a variety of food, but generally on insects, which they devour in large quantities; for they have a ravenous appetite. One has been known to devour thirteen cockchafers one after another.

Some of those living in the tropical regions are fruit eaters, and since they prefer the varieties most desired by man, they are often troublesome pests, flying in large flocks, like birds, at dusk. An instance is related that a bat was given a banana weighing two

ounces which it ate in three hours. The next day the bat was killed, and it was found to weigh only one ounce, half the weight of the food which it had eaten in three hours.

Night-Fliers

Bats are night-fliers. They secure all the food in the night, or twilight. Those which live on fruit, fly to a tree just at dawn which they have selected for their sleeping-place, and there they suspend themselves with their head downward, hanging by the hooks on their toes.

Their wings are folded close to their body. As they hook themselves upon the branches of the tree, they scramble hand over hand, or toe over toe, with some speed, biting one another severely with their sharp teeth, and striking out with the long claw of the thumb, all the while shrieking and cackling without ceasing.

Each newcomer is obliged to fly around the tree several times before it dares to hook on, being threatened from all points. And when he at last catches a limb, he must go through a series of combats, and probably be ejected two or three times before he can succeed in securing a quiet place to rest.

When these series of selfish wranglings are over, they settle down to several hours of profound sleep, during which time they hang suspended with their head downward.

Most other bats seek a different kind of retreat for their day's sleep and rest, such as hollow trees, caves, fissures in rocks, in and about buildings, unused chimneys, behind weather-boards and shutters which are not often used, or in any dark sheltered place, where they are not likely to be molested.

A Good Long Sleep

In cold regions, bats hibernate, or sleep in a dormant state, during the winter season, as do many other animals. In this state they require no food for months at a time, and they scarcely breathe once a day, and their hearts almost cease to beat. A few hours of warm sunshine will arouse them from their slumber, and they go in search of food, and then return to their lodging place, to continue their strange sleep.

They often pack themselves in caves, crevices and holes, and there they hang suspended, protected from the severe cold, until about the middle of March, or a little later, when they arouse from their winter's rest, and begin an earnest search for food to rebuild their wasted bodies.

Vampires

Like those whom the Bible says "love darkness rather than light," some bats have evil deeds. We have already referred to the quarrelsome spirit of the fruit-eating bats. Others live on birds' eggs, and even devour young birds.

There is one kind which is found in South America, called the Vampire, which lives on the blood of animals. They have sharp teeth of large size, which cut like a razor. As soon as the wound bleeds they feed on the blood. This bat has such a keen edged and cutting tooth, and such great skill, that it can wound the skin of an animal, or even of a man, without either alarming the sleeping one, or even appearing to cause any pain, and then considerable blood is drawn out and fed upon. Such cases have occurred and the sleeper has not been aware at all that he has been wounded. They

will not attack all persons, or animals, but choose their victims. These bats are large, often measuring two or three feet, when their wings are spread to the full extent.

It is interesting to know why they are called Vampire bats. The word Vampire means a blood-sucking ghost. In Russia, Poland, Servia and Austria, the natives supposed that the soul of some dead men left their buried body, and went out to suck the blood of living persons.

To put a stop to these ravages, a stake was driven through the body of the dead person, or boiling water and vinegar were poured upon the grave. Persons who were thought to have turned vampires were wizards, witches, suicides, and murdered persons. Sometimes a living person might become a vampire by leaving his body during sleep.

It is not strange that people who knew but little of the habits of these night-fliers, which attacked animals when asleep, and even men, and sucked their blood, should be called Vampires.

Bad Company

From their associations, as well as from their habits, bats have acquired an unenviable reputation. They have long been associated with churchyards, where their noises are heard in the darkness, and certain superstitious people have dreaded to pass such places, and so they have come to fear and dislike bats.

Angels are always represented as having wings of birds, while demons are given the wings and claws of bats. It seems unnatural that animals should be found in gloomy caves and tombs when the sun is shining so brightly outside, and so they have gotten themselves

feared and disliked by their choice of unpleasant surroundings.

People are known and judged by the company they keep, and by the surroundings they love. Bad associations, whether of persons or books, soon give one an unenviable reputation.

Bats cannot endure the light, and hence the remark, " as blind as a bat," doubtless due to the fact that they are blinded when driven out into the light.

Those who are accustomed to the dark, cannot enjoy the light, and are helpless in it. If one will not live in the light of truth, and of right doing, he soon comes to hate the light, and to love darkness. The open, frank and truthful person he cannot understand. The darkness of deceit and cunning are more enjoyable to him.

Seeing With Nose, Ears, and Wings

Bats have a highly organized sense of touch, so that they are able to fly in the darkest places, such as caves, which are totally dark. Yet they fly about without coming into contact with any projections, and turn corners as readily as if it were light. This is not because they see. It is because they feel their way. The sense of touch is very highly developed in their nasal appendages, or flaps of skin near their nose, which are large. There are similar delicate folded membranes near their ears, also the wings have very sensitive nerves.

Somewhat as the ears collect and transmit waves of sound, these membranes receive and transmit the vibrations which are communicated to them by the air from objects, so that the bat can tell as readily when it is near an object as if it saw it.

Probably no animal has such a delicate sense of touch as do bats. Such sensitive warners, or tactile guides as they are called, are needed, because they have to follow in swift evolutions the insects which people the air at night.

An Italian naturalist, by the name of Spallanzani, experimented with bats to see how well they could guide themselves when deprived of sight and hearing. Strings were suspended about the room, and yet the bats, blind and deaf, could fly among them without touching them, simply by their delicate sense of touch. Although unable to see or hear they could feel the slightest change of air produced by their coming near to the strings, and so were able to avoid them.

Sensing Danger

Here we have a valuable lesson. We are surrounded by evils on every hand. We are naturally blind and deaf to the presence of our spiritual foes. How are we to know when they are near us, and so keep ourselves from harm's way? Intellectual development, however keen, is not sufficient.

What the Creator has done for the bat, the Spirit of Christ will do for our hearts. We may so have Him with us that He will impart to us such a sensitive mind that we shall recognize in a moment the presence of that which is sinful and dangerous. That is the only way we can keep from going into dangerous places, and from associating with those who would do us harm, being led on by our ignorance. But He gives us a spiritual instinct, which enables us to recognize evil even before it presents itself. The Scriptures call this the discerning of spirits, and say that it is the gift of the Holy Spirit.

Shielded from Harm

There is another interesting thing about bats, and that is the way in which they care for their young. When the little ones are born, they are blind, helpless and naked, and so need the constant care of their parents.

The mother bat takes her little one under her wing, where it clings to her soft fur, while she flits about in search of food. The young one has the special faculty of clinging to its parent from the first moment that it comes into the world. There it clings, under the wing, close to her body, out of the way, while the mother is in swift pursuit of her prey. So long as it cannot fly, she thus carries it.

When she sleeps, it nestles under her wing by her side, and is never away from her for a moment. The mother will fight savagely to protect her young. In the meantime the little one clings to her so closely that it is difficult to get it loose from her, even after she is dead.

Here is a lesson for us. David prayed, "Hide me under the shadow of thy wings," and in the ninety-first Psalm we are told, "He shall cover thee with his pinions, and under his wings shalt thou trust." There is the safe place for us from every temptation, or fear of present or future foe. God takes all who will trust Him, under His immediate and constant care and protection, and guards them far more safely and tenderly than the mother bat seeks to care for her young, or any human mother could care for her child.

As the helpless little bat never ceases to cling to its mother, let us never wander from His side. Let us constantly keep in touch with Him, and at every ap-

proach of evil, we shall feel His shadow over us, and be able to rejoice in our security.

Questions for Review

1. What incident shows that bats do not like light?
2. What statement of the Prophet Isaiah shows that he was familiar with the habits of bats?
3. Where are bats often found in large numbers?
4. What shows that they are a very old race?
5. What does the name naturalists give them signify?
6. To what class of animals do they belong?
7. How many species of them are there?
8. Describe their bodies, as to size, spread of wings, forearm, hand, thumb, claws, etc.
9. What constitutes their wing?
10. How do they use their hands in flying?
11. How do they walk?
12. What must they do when they wish to fly?
13. What is their position when asleep? Why is this?
14. In what respect is the aeroplane like the bat?
15. How do they drink? Of what do they remind us in this?
16. What places do they love to frequent, and why?
17. On what food do they live?
18. What is the food of those in tropical regions?
19. When do they fly abroad?
20. What are their habits when seeking a place to sleep?
21. What is their attitude toward one another at such times?
22. What other retreats beside trees do they have?
23. How do they spend the winter?
24. What special places do they seek for such times?
25. Describe the vampire bats. What do they do for food?
26. Why are they called vampires?
27. How did their name originate? Give illustrations.

28. Why have bats acquired an undesirable reputation?

29. How are angels always represented in art? How are demons?

30. How do they remind us of those who prefer ignorance to truth?

31. What about the nervous sensibilities of bats?

32. What sense beside sight is highly developed in them?

33. What experiment illustrates their delicate sense of feeling?

34. How is this a suggestion to us as to the presence of danger?

35. What special monitor has been given to us to make us sensitive to the dangers of sin?

36. How are the young of bats shielded from harm?

37. Describe the protection which the mother bat gives her young.

38. How does this remind us of David's prayer? What was it?

39. Where is the safe retreat in which we may always abide?

XIII

THE MAGIC PICTURE

THE MUSIC OF THE SPHERES

"Hast thou not heard it, the universal music,
The throbbing harmony, the old eternal rhyme,
In the wild billows roaring,
In the mad torrent pouring,
And keeping with the stars its beat and march sublime?
Hast thou not heard it when the night was silent,
And nothing stirred but winds amid the trees,
And the star-orbs, strings of harps celestial,
Seemed quivering to the rush of melodies?

If in thy soul there pulse not some faint responsive echo
Of that supernal everlasting hymn,
Thou 'rt of the low earth, lowly,
Or livest life unholy,
Or dullest spiritual sense by carnal grossness dim.
Hear it, O poet, hear it! O preacher, give it welcome!
O loving heart, receive it, deep in thine inmost core,
The harmony of angels,—glory, forever glory,
Glory and peace and joy, and love forevermore!"

Anonymous.

Music is in all growing things;
Earth's silence lives, and throbs, and sings.

LATHROP.

Soft stillness and the night become the touches of sweet harmony.

Sit Jessica! Look how the floor of heaven is thick inlaid with patins of bright gold

There's not the smallest orb which thou beholdest,
But in his motion like an angel sings,
Still quiring to the young eyed cherubims;
Such harmony is in immortal souls;
But while this muddy vesture of decay,
Doth grossly close it in we cannot hear it.

SHAKESPEARE, "*Merchant of Venice.*"

The Father spake! In grand reverberations
Through space rolled on the mighty music tide,
While to its low, majestic modulations,
The clouds of chaos slowly swept aside.

And wheresoever, in his rich creation,
Sweet music breathes—in wave, or bird, or soul,
'Tis but the faint and far reverberation
Of that great tune to which the planets roll!

FRANCES S. OSGOOD, "*Music.*"

THE Magic Picture is purely a work of the imagination, but it is in keeping with the facts of science, as was brought out in the chapter, "Stones That Talk." It goes one step further, and would encourage each student of nature, by imagination, to make as real as possible the marvelous harmonies which exist about him on every hand.

It would go even beyond that, and inspire the realization of the fact that these earthly harmonies are but the response made by natural things to the superior and overmastering spiritual harmonies which lie just beyond the ken of our material existence; and the entrance into and enjoyment of which we ourselves may actually experience after the refining and spiritualizing of our nature, largely through the various testings which we are called upon to meet in life.

It precedes the thoughts on Telepathy, which gives us a view into the mysterious realm of our mental endowments, which is the antechamber of our spiritual nature.

The Picture

It was a small copy in colours, from Dresden, of Jacopo Palma's Mary and the Child, with John the Baptist and St. Katharine.

It hung on the wall where the setting sun could illuminate it with its soft, strong light.

It was a Sunday afternoon toward sunset, and Lilian, a crippled girl, wheeled her chair to the window to see the golden colours of the setting sun.

She scanned the gorgeous sight, and was charmed by the delicate harmonies there painted on the sky and clouds by the hand of the Creator, when she chanced to glance toward the small picture on the wall.

It was always beautiful to her; its deep rich colours, blending the vivid hues with those of more delicate shadings, but now it fascinated her. She could not take her eyes from it.

She gazed upon the refined but rugged face of John the Baptist; noticed the cross which his shepherd staff formed; observed the parchment roll in his hand and just touched by the fingers of Mary; noticed the wavy hair, the large eyes and refined face of St. Katharine; then glanced at Mary who had a deep inquiring look fastened upon John; the full beautiful face seemed to be speaking, though the lips were closed. Then she looked at the Babe with his little chubby arms clasped together over his mother's; noted his rosy cheeks, his large brown eyes, and the sweet half smile on his face.

Then she peered further into the picture, and

scanned the background, the landscape, the rugged hills and plains, and the various shades of colour on them, and saw the clouds in the sky, one of which was fleecy and bright, forming a startling contrast to all the others.

As she gazed upon the picture as a whole, that one light spot on the clouds grew brighter, and seemed to open, and enlarge more and more, until it filled all the background. Then a small speck was seen in the centre, as if it were alive, and it grew larger and more distinct, and it was approaching her.

It was a beautiful face, and other faces were seen near it, and these too continued to enlarge, multitudes of graceful beings, floating out and hovering in the sky, and above and around the little group of people of which the Babe was the centre.

She saw the Babe turn his eyes toward the sky, and at once all the hosts in the air began to wave their palms toward him, and they bowed again and again to him; and then one of them stood still on the air, wheeled about, and looked at the multitude of others. He raised his hand and gave one clear note of a song, and instantly all the others joined him in the same song.

She heard the words distinctly. As they sang they all kept time with their palms, waving them to and fro.

She saw that the words of their song were visible vibrations, like the ripples on water, or the dancing of the dust in a sunbeam. These waves were radiating in all directions. Some floated off to the clouds, and as soon as they touched the particles of the clouds, each bit of vapour was transformed, and was seen to be a tiny musical instrument which joined in the song,

until the great banks of clouds were sending out their harmonies along with the angels; and some of the waves of the song impinged upon the trees, and instantly all the leaves began to quiver, and then she saw that each leaf was composed of myriads of little harp-like musical instruments, and they all took up the notes of the same song, till all the trees in all the forests were heard singing that same song.

Some of the song was wafted to the earth, and all the flowers, and every blade of grass, and all the stones, and the dust of the streets, and the fields, and the bricks in the houses were all at once transformed into strange musical instruments, and all joined in making music in harmony with the same song.

Now the whole world was singing that song, and Lilian could not only hear the song, and see the musical instruments that made it, but she could see the waves of song.

She was well-nigh overcome with the delicate strains which were soft at first, and then grew louder and louder until the whole sky was filled with a mighty chorus, and then it faded out until she had to listen attentively to hear it.

While these billows of harmony were rising and falling, she saw that the Babe was looking off into the sky, observing what was transpiring.

Then she saw him look at her, and noticed that his lips began to move; and just then the music softened, and she heard him say: "Lilian, all this music and harmony in heaven and on earth, I have left behind. I gave up all to live amid the darkness and discords of sin, that you may hear and see the music of the Father, in heaven above, and on earth beneath. Be patient in your suffering, and soon you shall live

eternally in the presence of all these holy, happy angels, and shall forever see, hear and join in the songs of God, and of His creation."

Then the Child looked toward John, and toward his mother, but they did not see his eyes fastened upon them. They still looked straight at each other.

Mary's lips began to move. She said: "John, do you not hear something?"

And he replied: "Yes, I hear the soft sighing of the breezes as they play among the rustling leaves."

And St. Katharine said: "I hear the delicate rays of sunshine, as they dance upon the flowers, and the green fields."

"Yes," said Mary, "and I hear the roll of distant thunder, as if a storm were brewing. I hope it will not frighten my darling Babe. He has never yet seen a thunder storm."

And John replied: "I take all this to mean that the Babe will hear, in this world, the songs of the birds, and will see the beautiful things, but also that he will feel the force of the dark and terrible things. Here the gentle and severe are strangely commingled."

Then the Babe looked toward Lilian and smiled, and said: "They do not hear all yet, and fail to see many things, but they shall hear and see, for the heavens and the earth shall be opened to them too."

Then he turned his eyes toward the heavenly hosts, that were still singing in the sky, and they all bowed and waved their palms to him, and he said to them: "In a little while you shall come again, and I will return with you, and the whole world shall hear the song."

As his last word was spoken, all the heavenly ones vanished, and the leaves ceased moving, and the flowers

and the grasses became quiet, and the clouds settled down to their former shapes, and all the bright colours faded out of the sky, and everything was still.

Lilian looked again at the faces in the picture, and they had lost their lifelike aspect, and were just as she had always seen them.

The magic picture had closed all its mysterious portals; the white fleecy cloud lay in the sky on the background, just as it was before.

Now the picture was only a small card, beautifully coloured it is true, but its fascinating charm was gone.

She turned and looked out of the window, and saw the western sky all aglow with gold and crimson and violet, the sun was sinking behind a great bank of blood red clouds, and the trees were still, and the morning-glories were gently folding their arms over their breast, and the grass was green and quiet, and Lilian thought: "I wonder if this world is filled with such heavenly beings who are now singing their songs, and if the clouds and leaves and flowers and grass and dust and the rocks are all joining in that song with the angels!

"I wonder if I shall ever hear all those songs, and shall see them too, as I saw them in the picture!

"I wonder too, if I shall see the Babe coming again, along with all those beautiful beings, as he said to me from the picture; and if I shall hear the songs from everywhere, in the sky, and on the clouds, and from the trees, and the sunset, and the flowers and the fields, and the stones, and if I shall see the music too!

"I wonder if I shall hear all the people on earth join in that glorious and beautiful song!"

Then the sun hid his face, and the darkness began to close in around her, and she glanced down at her

open Bible, and read these words: "Hereafter you shall see the heaven opened, and the angels of God ascending and descending with and around the Son of man."

And these words explained to Lilian the significance of what she had seen and heard from the Magic Picture, and her heart was happy.

Questions for Review

1. Is the Magic Picture the statement of a fact of experience, or a work of the imagination?
2. Does it conform to the facts of science as we know nature?
3. What would it teach, as to the harmonies of nature?
4. What would it encourage in us as to our entrance into the higher spiritual harmonies?
5. Can you describe the "music of the spheres," as given by an anonymous poet?
6. What does Lathrop say of the music in nature?
7. What is Shakespeare's familiar quotation from the Merchant of Venice, along this line?
8. What does Frances Osgood say of God's utterance, as manifest in nature?
9. Of what painting is the Magic Picture a copy?
10. Describe the picture, and its subjects.
11. Who is represented as seeing new things in it?
12. What was seen in the sky?
13. What was heard? What about the colours?
14. What response was made by the objects on earth to those harmonies in the sky?
15. What did the Babe in the picture seem to be doing? What did he say?
16. Were the others seemingly speaking? Who were they and what did they say?
17. When the Babe looked toward the sky, what did the hosts up there do?

18. When he ceased speaking, what occurred?

19. How did the picture now look?

20. How did the sky, and other objects in nature, then look to her?

21. What were the questions which the girl then put to herself?

22. How did a verse in the Bible seem to answer her interrogations?

XIV

TELEPATHY

IT is a long way from the Island Universes in the heavens, a million or more light years distant, to the mind of man.

Beginning with the outermost bounds of creation, we then descended beneath us far beyond the reach of the microscope, a distance comparable with that to the most distant star in the sky, and there beheld the galaxies and systems, and suns and satellites of that realm, the molecules, the atoms, electrons, protons and photons, all performing their allotted mission.

We then viewed the earth in its primitive state, and saw its rocky surface rent and torn and worn to form Sand and Soil, and looked toward the Sea, and sought out its mission and marvels; and then the Snow, and its part in the long drama being enacted for the welfare of man.

Then " Stones That Talk " recited their wondrous messages; and the first forms of life came into view in the Lichens; and there followed in their train the fungi, in the Mushrooms; and the stately, once reverenced Mistletoe recounted her wonders; and then we saw worthless, thorn-bearing trees, in Grafting, transformed into invaluable aids to man.

Then that essential in all animal life, Blood appeared, a thing more wonderful than the suns in Andromeda. Then a strange quadruped, in the Bat, came into view, passed before us, and imparted, like all its predecessors, helpful moral lessons.

Our senses became quickened ten thousand fold, and we saw and heard, in "The Magic Picture," the harmonies which lie beyond our ken because at present, we live in a narrow house of clay, very limited and unrefined.

And finally the journey ends as we step over the threshold of man's mental being, into the vestibule of his spirit, and discover the marvelous interpretations which he makes of the ether waves that impinge upon his brain cells; and here in Telepathy, we learn something of the nature of the language of heaven.

Telepathy

To all young people telepathy is quite likely to be a very attractive thing. Very often showmen come to town, and astonish the multitudes by their displays of what seems to be very superior wisdom, in being able to find things which are concealed by some one in the audience, or by their ability to read hidden messages, or by informing people of what they are thinking.

These things are often carried so far that the wise man, or woman, will advertise in the press to answer any kind of a question regarding the secrets of life, and to solve all its problems, and to advise as to the best course to pursue in all doubtful matters.

It is advisable to know the truth about such matters, in order to be able to distinguish between what is true science, and what is false fortune telling.

Mind-Reading

Undoubtedly there is such a thing as mind-reading in certain cases, not in every one by any means.

From many years it has been known, and abundantly

demonstrated, that some people have the ability to read certain thoughts of others, and that not by any process of reasoning, but by simple intuitive impressions.

Very frequently children possess this faculty for mind-reading in a remarkable degree. Perhaps fifty years ago, the *Edinborough Review* gave the account of a girl, who could be blindfolded, and yet go directly to anything which had been hidden from her. It was noticed, however, that the people were always present, and knew the location of the hidden article.

The famous astronomical writer, Richard Proctor, gave an explanation of the case, long before ether waves, much less radio, were known.

He likened the brain cells to miniature tuning forks, which by thought, may be attuned to a certain pitch. When thought waves, sent out from brain cells of the audience, fall upon a sensitive brain, like that of the child, her brain cell-tuning forks, being of the same pitch as theirs, respond, producing similar thoughts to theirs, and she finds the article.

This is substantially the explanation which would be given of such mind-reading to-day.

Among the games of young people of half a century ago, the company would hide an article, and then call in one of their number from out of the room, and he would search for it, while all of the others kept thinking of its location, to aid him in his search. It was no unusual thing for it to be located very quickly.

Twenty-five years ago on shipboard, in the men's cabin, we were discussing the subject, when a traveling salesman said that it was easy to him. We blindfolded him, and hid articles.

He took hold of the wrist of one of the party, while

all the others concentrated their thought on where the object was located. He had no difficulty at all in finding the article so hidden.

In this case, no doubt thought transference was materially aided by his hold upon the wrist of one of the company.

A Frequent Occurrence

Such experiences are much more common occurrences than is realized. In the home, on the streets, everywhere, two persons of congenial natures, often begin conversing on a subject upon which one of them has just been thinking, and then the exclamation: "How did you come to speak of that? I was thinking of it myself."

Such occurrences are all the more frequent between husbands and wives who have grown, year after year, to think alike, or are mentally and morally of the same key-note.

Not Occultism

While this is a wonderful, and often very mysterious, experience between people, it is not occultism, in the sense that it is a supernatural power derived from higher beings, or departed spirits. It is perfectly natural, and is readily explained by natural laws.

It is very true that not all can read the mind of others with equal facility and certainty.

Some possess this ability from childhood, and very often are not aware that they differ in any wise from other children.

Generally they are sensitive to impressions, and if they practice mind-reading as they grow older, they

may become hypersensitive to the thoughts of others. This is not necessarily a desirable acquisition, for several reasons, as we shall see later.

Who has not noticed how readily infants, and animals, seem to read the feeling of others toward them? Infants will shun those who do not care for babies. Cats and dogs, horses and cows, and all kinds of animals, know when the one approaching them is angry, or does not like them.

"Most of our actual knowledge of one another is derived through telepathy. Birds, and all the lower order of animals communicate thus with one another. Crows know when you carry a gun. Horses catch a sense of your worry. Woe to the one who tries to cover his inner dislike of children with soft and tender words! The repellent crying of the infant is generally an open rebuke." [1]

The writer had a dear friend who, from childhood, had his subconscious mind very close to the threshold of consciousness, as we would say. Like an uncle before him, he sensed what people thought, and in some cases this faculty led him to hear and see things which bordered on the uncanny occult.

When he was a child, one of the family, a servant, was very ill, and he was sent from home, so as not to be there in case of her death, which occurred in a few days.

He later returned home, and was walking through the village, holding on to the hand of another maid in the family. As they passed the churchyard, he broke loose from her hand, and ran to the fence, and pointed to a new made grave, and cried, "I see Mary over there!"

[1] "Through Science to God," p. 163.

In fear and consternation the attendant maid caught him, and hurried away, believing that he "had seen a ghost."

Her thoughts being upon the one who had died, as they passed the cemetery, were transmitted to his sensitive nature, and made upon his brain the impression which was sent out by her brain, and down the nerves of her arm, and he interpreted the impression as caused by an actual sight of Mary.

Mind Using the Body

In the cases mentioned above, we see that the telepathy was made possible because the mind expressed itself through energy which came from the rupture, or explosive force in brain cells. This passed in waves over the body, or was sent as ether waves, to impinge upon other nerves and brains, which were in tune with the waves transmitted.

The recipient of such telepathic messages uses his brain, and nervous organism no less truly, as a receiving instrument, though unconsciously, than the transmitter of the thoughts.

On the other hand, the originator of the thought-waves may at the time, be wholly unconscious that he is even thinking on the subject in hand. It may possibly be only a suggestion which has lodged in his subconscious mind, and is wrought into effective operation while he is unconscious in sleep.

All of the things which we say that we hear and see, are simply the interpretation which our mind makes of the impressions which certain waves make upon our nervous organism, and are then sent to the brain.

In every case where we receive information from others, or any knowledge from the exterior world, it is

the mind which interprets the impressions which are made upon our brain cells, which we use as an instrument, or medium of information.

It is no more wonderful, then, that we should receive and interpret impressions made upon our brain by thought waves, sent out by others, perhaps a thousand miles away, than that we should receive and read the messages sent us by light waves from the Pleiades, a journey of 325 light years away, or that we should transform ether vibrations from the clouds, and sunsets, into the colours red, yellow and violet. The only difference is that the latter is a more usual thing, and is constantly experienced by every one, while the former are less frequent, and are not the usual experiences of every one.

Cornelia Minor Arnold has expressed the thought thus:

" When soul with soul vibrates in perfect tune,
The waves etheric scorn both word and space.
Deep as the universe the mystic rune,
Though eyes gaze not on the beloved face.
Whose potent will but God's has power to stay,
What shall forbid, and who shall say them nay? "

Bible Examples

There are many examples of telepathy in the Bible. It is necessary to cite only a few references. Those who are interested may find a full discussion of the subject in Dr. Horace S. Stanton's " Telepathy in the Celestial World," Revell Company.

Several times it is said that Jesus " knew their thoughts." " He knew what was in man." Elisha repeatedly read the mind of the distant king of Syria,

whose servant said to the king: "Elisha the prophet that is in Israel, telleth the king of Israel the words that thou speakest in thy bedchamber."

Peter read the mind of Ananias and Sapphira, and exposed their falsehoods. And all the prophets were communicated with in a direct, and telepathic way by the Holy Spirit. Many examples of such communication, as recorded in the Bible, might be given.

Many Illustrations

In sound, electricity and light, there are many illustrations which help to make clear the manner in which brains and minds of persons may respond to one another, and produce what we term mind-reading, or telepathy.

"Everything has its key-note; this is because all objects vibrate. There is not an atom or a molecule anywhere, but vibrates as it sweeps onward. All things when in a normal condition are in a state of equilibrium, and things in equilibrium are easily moved.

"A piano is an apt illustration. Press down one of the keys very gently, so that the hammer does not strike the wire and yet lifts the felt. Now the wire is in a state of equilibrium and is easily moved. Strike the key an octave higher, and immediately release it, so that the felt will drop down upon it and stop the vibration. You hear the response of the one being held down. It sounds the same note as the one struck, because the wire vibrates in segments. But reverse the process, pressing down the higher key and striking the lower one, and you hear the higher one respond, but an octave higher than the one you struck. In this manner you can obtain response two or three octaves away.

"Put your foot on the pedal, lifting all the felts from the wires, and call into the piano; all the wires in unison with your voice respond in the same key.

"A violin held to the ear near an open piano, when a key is struck, responds with like tone. The two are in accord.

"If two clocks, hung on the wall, have the same length of pendulum, the ticking of the one will start the other,—only, however, when the swing of the pendulum in both is timed alike.

"Two tuning forks of the same vibratory rate are mounted upon resonating boxes. One is placed on a table, and the other is held in the hand near by. If the fork in the hand be struck, and then grasped to stop its vibrating, the other will be heard responding. Under favourable conditions this response can be heard by a large audience when the forks are twelve or more feet apart."

The secret of the radio lies along this line. The receiving instrument is so constructed that it is in tune with the length of the waves sent out by the transmitter, and can be changed to different keys as the waves from different stations change the length of the waves sent out.

"It is a frequent occurrence for a dog to howl when he hears a certain church bell, or a particular steam whistle. A friend has a dog which he takes by the fore paws, and begins to run up the musical scale. When he reaches a certain note, and prolongs it, the dog raises his head and howls in the same key. The dog, hearing his particular key-note, feels a peculiar thrill pass over him, and gives vent to his feeling in a howl.

"The human mind reveals that within it, the same

law of resonance operates. One meets a stranger and synchronizes with him at once, 'love at first sight'; but another person, though of equally good reputation and noble character, may produce a repellent feeling. Their key-notes are different."

Brain cells are ether-wave transmitters. The laws which make telepathy possible, are those which are manifest on every hand. They are the same by means of which we see and hear.

Our Knowledge of the Future

King Richard of England was imprisoned in the Lowenstein Castle on the Rhine. His prison was kept a secret. His servant Blondel wandered up and down the land singing near every prison the song which he and his master used to sing together. At last he was rewarded as he sang near the Lowenstein Castle, by hearing his song responded to, and sung in unison with him from behind the grim prison walls. He knew that he had found his king.

"God sings, over our imprisoned spirit, His note of exquisite harmony and sympathy, and when at last our dormant capacity is quickened into response, and we sing His song along with Him, our whole nature is vibrant with the harmony of heaven." [1]

Doubtless the method of communication in our future spiritual existence will be in harmony with the telepathic method; that is, directly, without any spoken words to be uttered. Then men shall know one another directly, and accurately. Nothing will be covered or concealed. And in those who are pure in heart, cleansed from all sin, there will be nothing which they will wish to hide.

[1] "Through Science to God," pp. 149–169.

In that happy life there will be no nerves to become weary; no organs of sight or hearing to get out of tune; no brain fag; no nerves to decay, and so there will be nothing which will give false impressions.

Is Telepathy Desirable?

While it is employed by all people in a limited way, and is most useful, it is fortunate for us that it seems to have been divinely hedged about by difficulties, lest we should carry it too far, and have it cause us injury.

Mothers come to know quite accurately the minds of their children; men and women intuitively sense the real inner attitude of others toward them, and there is such a thing as the " discernment of spirits," which is by divine illumination, and is most important. All public speakers of long experience are able to sense the attitude of their auditors toward them, and the truth which they present.

And the ability to communicate with others telepathically, may be cultivated, and by practice, largely developed. But it is very questionable if it is desirable to do this.

We are beings with a very wonderful and delicate nervous organism. In some persons this is abnormally sensitive. By practice others may educate their nerves and brains to become unusually sensitive to wave impulses which fall upon them. But it is generally true that neither of these is a healthy condition for the body or mind of the possessor.

God has limited our ability to hear sound waves, and to see the ether vibrations, and those who are able to hear higher notes than the average person in good health, or to sense higher light waves, are very likely

to be delicately nervous people, and are subject to nervous and mental disorders in consequence.

The author has known most estimable, and cultured people who have developed themselves into such a sensitive state nervously and mentally, that they came to be marvelous mind readers, and clairvoyants. Their revelations were astonishing.

But it invariably injured their health, and some of them broke nervously, and prematurely ended their days as a consequence.

We would class this along with hypnotism, and occultism generally, as an unhealthy and dangerous practice, which should be used sparingly.

We must always remember that we have bodies, which rightly used and not abused, are God given and wonderful instruments of the mind and spirit. But if we misuse the instrument, we must pay the penalty in pain, and an untimely death.

Telepathy at best is only a hint of the marvelous extension of our knowledge which awaits us in the future life, and the joy which it will be to us, provided our spirit is attuned to God, and to the holy life of heaven. But if we are discordant notes, here or there, we cannot know peace.

Questions for Review

1. What makes telepathy interesting, particularly to young people?
2. How far do showmen often carry the mystery of mind-reading?
3. Why is it desirable to know something of the science underlying mind-reading?
4. In actual experience, is there such a thing as mind-reading?

5. Is this true, in all persons, alike?

6. What is the case mentioned in the *Edinburgh Review?*

7. How did Richard Proctor explain this?

8. How is this sometimes shown in games of young people?

9. Relate the incident which occurred on shipboard.

10. In this case how was thought transference aided?

11. How is it shown that such occurrences are common? Between whom is it most common?

12. In what sense is this not occultism?

13. What kind of persons most readily read the mind of others?

14. How is this noticed among animals, and infants?

15. How is most of our knowledge of one another gained? Give examples.

16. Give the incident of the child seeing one, in a cemetery, who had died.

17. What is the explanation of that vision?

18. What physical operation in that incident made telepathy more easily experienced?

19. Does the recipient of thought transference have any part in the operation? If so, what?

20. Is the originator of such thought waves always conscious of them? Specify.

21. What are the things which we see and hear the result of?

22. What is it in us which enables us to know the exterior world?

23. What about the marvel of our reception of waves from distant suns?

24. Why does telepathy seem more wonderful to us than that?

25. What are Cornelia M. Arnold's words regarding telepathy?

26. What are some of the examples in the Bible of thought reading?

27. What things in the exterior world help to make the matter clear?
28. Why have all objects their key-note?
29. Show how a piano is an apt illustration of this.
30. How does a violin, or a clock illustrate this?
31. Illustrate this law by tuning forks.
32. What is the secret of the radio?
33. How does a dog sometimes illustrate this?
34. How does the human mind illustrate that the same law of resonance operates there?
35. What part do brain cells play in this?
36. Give the historical incident in the life of King Richard which illustrates how God comes to us.
37. What sort of communication with one another will we doubtless have in the future life?
38. Why will spoken words be unnecessary then?
39. What will constitute our happiness then?
40. Is telepathy frequently, but unknowingly employed? Give examples.
41. How may this ability to communicate with one another develop?
42. Is such a practice always desirable?
43. What kind of persons most readily acquire such skill?
44. What incident illustrates the danger in such practices?
45. With what other things is it classed as dangerous?
46. Of what is telepathy a hint as to our future?

INDEX

Abysmal theory of light, 107.
Acalephæ, and Medusæ, 116.
Acidity of roots, 169.
Action, harmony of, 66.
Acts out of place, 65.
Adaptation to environment, 23.
Aeroplane, how copied bats, 236.
Agaricus, mushrooms, 182.
Age of sand, 68.
Air, molecules in, 33–34.
Alpha Centauri, distance to, 25.
Andromeda, nebula of, 26.
Andromeda nebula, distance to, 27.
Andromeda, years of, 40.
Animal and Vegetable, differences, 215.
Animal life in the sea, 106.
Animals' bodies, per cent. of water in, 81.
Animals, light of, 106.
Angels in art, 239.
Archimedes', lever of, 17.
Arnold, Cornelia M., on telepathy, 260.
Asgard, plains of, 195.
Ass, speaking of, 150.
Asteroids, 23.
Atmosphere, spiritual, 173.
Atoms, 35.
Atoms, attraction of unlike, 35.
Atoms, conception of, 32.
Atoms, description of, 35–36.
Atoms, differences between, 40.
Atoms, distance of from us, 40.
Atoms in a cubic cm. of steel, 37.
Atoms in a drop of sea water, 120–123.
Atoms like gyroscopes, 134.
Atoms, motion of, 38.
Atoms record and repeat, 155.
Atoms, size of, 36.
Atoms, the number of different, 35.
Attraction, effects of, 35.
Avalanches, 136–137.
Avalanches, cause of, 137.

Baalam's sight of angel, 150.
Bad company, 239.
Balder, the god, 194.
Bateman, Canon, on sea sights, 106.
Bats, ancient race, 234.
Bats and light, 233.
Bats, bodies of, 234–236.
Bats, habits of, 233–242.
Beauties of the sea, 99.
Beauty of God in snow, 138.
Beauty of nature, a type, 142.
Beauty, two kinds of, 131.
Beginning, when, 5.
Belief, our childhood, 13.
Bible and blood, 223–225.
Blizzard, a snow, 136.
Blood, 215.
Blood, a living liquid, 216.
Blood, chlorophyl, how like, 188.
Blood clots, value of, 220.
Blood, contact with necessary, 222.
Blood disks, 39.
Blood, faith in, 226.
Blood, highly complex, 228.
Blood, like a river, 228.
Blood, mission of, 221.
Blood, sacred, 223.
Blood, symbolical character of, 225.
Blood tells, 227–229.
Blotting, sand in, 61.
Blowing sand, 58.
Body, captivity to the, 177.

Bohr, Niels, on electrons, 38.
Book of our lives, 158.
Brain cells as transmitters, 263.
Breath, molecules in a, 34.
Brennen, Alpine guide, 137.

Calcareous sand, 54.
Carow, Edith Kermit, 230.
Carpenter, Dr., on phosphorescence, 105.
Cement, why needs sand, 51.
Centrifugal force, and centripetal, 18.
Chalk speaks, 151.
Chamois hunters and avalanches, 137.
Character, finding its level, 65.
Chemical affinity, 5.
Childhood beliefs, 13.
Chladni figures, 66.
Chlorophyl, 187.
Chlorophyl, like blood, 188.
Christ, union with and results, 65, 224.
Churchill, Winston, 230.
Cleveland, Grover, 230.
Climate and sand, 53.
Climate and snow, 131.
Cœlenterates, 118, 119.
Colouring of animals, 100.
Colourless corpuscles, 218.
Colours, song of, 154.
Combinations, utility of, 66.
Compton, Professor, illustration by, 33.
Coöperation taught by coral, 114.
Copper, how it speaks, 153.
Coral, and coral reefs, 110–111.
Coral, composition of, 113.
Coral, how formed, 114.
Coral, value of, 113.
Corpuscles, a system, 39.
Corpuscles, 217–218.
Corpuscles, sacrifice of, 219.
Cosmic rays, 70.
Creation, a continuous process, 143.
Creation, beauty in, 132.
Creation, the new, 143.
Creation, size of, 28.
Creator, how symbolized by sun, 20.
Creator, wisdom of, 34.
Currents in the sea, 86, 89.

D'Albe, F. F., 71.
Dana, James D., on coral reefs, 112.
Dance, a dizzy, 123.
Danger in snow, 135.
Danger, sensing of, 241.
Darkness, lovers of, 233.
Darkness, provision for, 107.
Darwin, Charles, on lichens, 174.
Darwin on Phosphorescence of sea, 105.
Death, beyond the reach of, 173.
Deep, life in the, 115.
Deep, the silent, 115.
Demons, represented in art, 239.
Deserts, musical notes in, 66.
Design in nature, 114.
Divine energy on atoms, 40.
Dog's howl, and keynote, 262.
Dooly, Rev. John, illustration by, 228.
Drop of sea water, how composed, 120–122.
Druids, 196.
Drummond, Henry, on parasites, 199.
Duncan, Captain, on icebergs, 90.
Duplex existence of lichens, 176.
Durability of man's spirit, 68.
Durability of sand, 68.
Dust and soil, 45.
Dust, sources of, 45.
Dutertre, on jelly fish, 117.
Dwight, Timothy, 229.
Dwight, T. W., 230.

Early grafting, 212.
Earth, compared with suns, 19.
Earth, density of, if doubled, 18.

Earth, energy of from the sun, 19.
Earth, in early geological ages, 43.
Earth, mysteries of, 15–16.
Earth, rotation of and trade-winds, 131.
Earth, rotation of and sea currents, 87.
Earth, speed of eastward, 16, 88.
Earth, two revolutions, 14, 16.
Edwards, Jonathan, 229.
Egypt, tombs of and sand, 57.
Electric force and red lead, 66.
"Electricity and its similitudes," 154.
Electrons, 37.
Electrons, force of, 71.
Electrons in a drop of sea water, 120–124.
Electrons, nature of, 37.
Electrons, operation and presence, 38–39.
Electrons, revolutions of, 71.
Electrons, speed of, 38.
Electrons, the year of, 40.
Electrons, to create one gram of, 71.
Engraving by sand blasts, 59–60.
Environment, superior to, 171.
Equilibrium, 71.
Equilibrium between land and sea, 48.
Erasing our record, 160.
Evaporation, causes of, 82.

Faith, an incident concerning, 126, 127.
Faith in the blood, 226.
Family, a drop of sea water like, 120–122.
Feeling, the sense of in bats, 240–241.
Filtering water by sand, 53, 54.
First farmers, the, 168.
Fixed stars, 24.
Flowering animals of the sea, 99–100, 109.
Food of fungi, 184.
Food-value of lichens, 173.
Forbes, Edward on sea forests, 95.
Force, vital power in, 170.
Forests in the sea, 95.
Fraunhofer, lines of, 15–16.
Frigga, the goddess, 195.
Fruit, two kinds in life, 212.
Fungi, food of, 184.
Future, our knowledge in the, 263.

Galaxy, defined, and size of, 25.
Gardens, flower in the sea, 100.
Gases, work of on rocks, 45.
Gates, Merrill E., 230.
Genealogy, importance of, 227–230.
Glass, light registered in, 157.
Glass, sand used in making, 51.
God and little things, 39.
God, care of for us, 29, 39.
God, dependence on, 24.
God, growing conception of, 28.
God, incarnate, 173.
God, mercies of as sands, 50.
God, protection by, 242.
God, source of energy, 40.
God's interest in us, 15, 39.
God's love of beauty, 100.
God's provision for darkness, 107–109.
God's thought seen in snow, 132.
Grafting, early, 210.
Grafting, necessity of, methods, 206–210.
Grant, U. S., 230.
Gravitation, law of, 21.
Gravitation, overcome by motion, 17.
Gravitation, reduction of, 18.
Green color in plants, 186.
Gulf Stream, 88–89.
Gurnards, beauties of, 101.
Gyroscope, 18.

Hallelujah chorus of the trees, 153.
Harm, shielded from, 242.

Heavenly Father, the care of the, 29.
Heredity, importance of, 229.
Hibernation of bats, 238.
History of a grain of sand, 73.
Hoder, the god, 195.
Homes, the centre of the world, 15.
Hope, transient, like sand, 65.
Hopkins, Mark, 190.
Hour glass, 50.
Hubble, Major, 27.
Human nature and sand blasts, 60.
Human nature, complex, 177.
Human parasites, 200.
Huxley, Thomas, on contact with blood, 222.
Hydra of the sea, 112.

Icebergs, 90.
Iceland moss, 174.
Ice, work of on earth, 44.
Imagination, importance of, 246–247.
Importance, our, 15.
Infusorial earth, 48.
Ingratitude, like quicksand, 65.
Inhabitants of the planets, 23–24.
Insomnia, 61.
Intelligence seen in snow, 135.
Iron filings and electric force, 66.
Island Universe in Andromeda, 27.

Jelly fish, numbers, stinging, etc., 116–118.
Jesus' appearance to John, 142.
Jesus' teaching on blood, 224.
Jesus, triumphal entry of, 147.
John on Patmos, 142.
Jones, T. Raymer, 118.
Joshua, and the witness stone, 148.
"Jukes, Margaret," 228.
Jupiter, distance, day and size, 22.

Kelvin, Lord, on molecules, 33, 36.
Key-note, importance of, 261–263.
King Richard, how found, 263.
Knowledge, ours in the future, 263.

Land and water, coördination, 48.
Landscape, beauty of, 43.
Leaves, starved, and fading, 154.
Le Conte, on corals, 113.
Legends of the mistletoe, 194.
Leucocytes, of the blood, 220.
Lichens and their uses, 164–166.
Lichens, duplex existence, 176.
Lichens, food value of, 173.
Lichens, vicarious sacrifice, 170.
Lichens, what, descriptions, 164.
Lichens, work of, "script like," 166.
Life, a brief, 190.
Life, adaptations of, 103.
Life among atoms, 40.
Life, and little things, 67.
Life, first appearance of, 44.
Life in only one world, 188.
Life in sea, and on land, 103.
Life in the deep, 102, 116.
Life, living the lower, 191.
"Life of flesh in the blood," 216.
Life recorded in nature, 158–159.
Life struggles in the sea, 103.
Life, value of abundant, 171.
Life, zones and variety in sea, 96.
Light carries pictures, 157.
Light, effect of on bats, 233.
Light, registered in glass, 157.
Light turned to darkness, 160.
Little things and God, 39.
Living lamps of the sea, 106.
Living liquid, blood a, 216.
Livingstone on sand rivers, 56.
Loki, 194.
Longevity of lichens, 172.

Longfellow, on Baldar's death, 196.
Love, the motive power of, 144.
Lyell, on sand storms, 58.
Lymph of blood, 221.

Magic Picture, 246–252.
Man, durability of spirit of, 68.
Man, inner light in, 107.
Man, littleness of, 41.
Mangin, Arthur, on lichens, 175.
" Manna " lichens, 175.
Mars, day and distance of, 21.
Medusa, 116.
Men shine, 108.
Men, vanity of, 14.
Mercury, day, and distance of, 21.
Metaphors in quicksand, 64.
Metchnikoff, on blood corpuscles, 219.
Milky Way, size of, 25.
Millikan, R. A., on cosmic rays, 70.
Mind and telepathy, 261.
Mind using the body, 259.
Minerals and soil formation, 45.
Minerals in sea, source of, 84–85.
Minerals in sea water, 84.
Mines of ore speak, 153.
Mission of the blood, 221.
Mississippi river, soil transportation by, 56.
Mistletoe, legends of, 194.
Mistletoe, name and reverence for, 199, 200.
Molecule, definition of, 32–33.
Molecule of sea water, 120.
Molecules in electric light bulb, 34.
Molecules, motion, size of, 34.
Molecules, the sight of, 38.
Mollusks, coral, 112.
Moon, map and mountains of, 23.
Mortar, how made, 51.
Motherly protection of bat, 242.
Mountains in the sea, 93.
Mountains, snow on, 140.
Mushrooms, where, how known, 181–191.
Music in growing things, 245.
" Music of the Spheres," poem, 245.
Mysteries of the earth, 16.

Natural fruit trees, 206.
Natural, man, 188–189.
Nature, if sand removed, 69.
Nebula, Andromeda, 26.
Nebulæ, what and numbers of, 26–28.
Neptune, day, and distance to, 22.
New Powers and Possibilities, 215.
New Testament teaching on blood, 224.
New tree, and new life, 210.
Night-Fliers, 237.

Obscuring Nebulæ, 26.
Ocean currents as symbols, 91.
Ocean, deep currents in, 91.
Ocean tides, 92.
Occultism, 257.
Odin, the god, 194.
Omar, the mosque of, 14.
Ooze of the sea, 96.
Ore mines speak, 153.
Orion, distance, size of, 14, 25.
Osgood, on visible music, 246.
Oxygen, and rust, etc., 45.
Oxygen and the blood, 218.

Paine, Robert Treat, 230.
Palma, Jocopo, picture by, 247.
Parasite, the mistletoe, 197.
Parasites, 183-184.
Parasites, human, 185, 200.
Pascal's paradox, 41.
Pauper of nature, 202.
Phosphorescence of the sea, 105.
Photons, 36, 37.
" Picture, the Magic," 246.
Picture, a drop of sea water family, 120–124.
Pictures carried by light, 157.
Place, everything in its, 67.
Place, out of one's, 67.

Planets, are they inhabited? 23.
Planets, speed of the, 21–22.
Plant, stalks and silica in, 53.
Pleiades, 14.
Polyps, coral making, 112.
Preservation by sand, 57.
Proctor, Richard, mind reading, 256.
Protection, the Divine, 242.
Protective colouring, 100.
Protons, 36, 37.
Protoplasm, 184.
Protozoa, 116.
Pruning, necessity of, 209, 212.
Psalm 107, and the sea, 79.
Purity, God's desire for, 144.

Quartz, composition of, 48, 52.
Quicksand, haste over and rescue from, 63.
Quicksand, nature, etc., a metaphor, 61–64.

Radio and telepathy, 262.
Radium, disintegration of, 70.
Record, one's erased, 160.
Red corpuscles, 217–218.
Reeve, Sarah Tapping, 229.
Reindeer, food of, 175.
Riker, L. C., on Gulf Stream, 88.
Rivers in the sea, 89–90.
Rivers of sand, 56.
Rivers, transportation by, 56.
Rocks tell their story, 152.
Rocks, tillers of the, 168.
Rocky surface of the earth, 43.
Rogers on chamois hunters, 137.

Sacred, the blood, 223.
Sahara desert, 55, 58.
Salt in sea, the total, 85.
Salvation, working out of, 202.
Sand, age of, 68.
Sand, a grain of a symbol, 72.
Sand, a measurer of time, 50.
Sand and climate, 53.
Sand, a symbol of God's mercies, 50.
Sand, and rhythmic motions, 66.
Sand, benefit on seashore, 46.
Sand blasts, 58–59.
Sand, blowing of, 54.
Sand, calcareous, 54.
Sand, combinations of, 66.
Sand, counting of, 49.
Sand dunes, 55.
Sand, durability of, 68.
Sand, flexibility of, 46.
Sand, history of one grain, 73.
Sand, how formed, 47.
Sand, if there were none, 69.
Sand, impervious to water, 62.
Sand, in glass making, 51.
Sand, in horticulture, 53.
Sand, injury done by blowing, 54, 55.
Sand, instrument of corrosion, 58.
Sand, launching of ships and, 53.
Sand, layers of, 65.
Sand, minerals in, 46.
Sand, musical notes by, 66.
Sand, numbering of, 36, 49.
Sand, out of its place, 67.
Sand, planing of rocks by, 58.
Sand, presence of on earth, 48.
Sand, preservation by, 57.
Sand rivers, 56.
Sand, seeking its level, 65.
Sand, uses of, 51.
Sand, what it is, 47.
Sand, within one grain of, 70.
Sand, yielding nature of, 60–61.
Sandstone, colours and uses, 52.
Satellites, 23.
Saturn, 22.
Saturn, distance to and day of, 22.
Schleiden, Professor on sea vegetation, 102.
Scoresby on jelly fish, 117.
Sea, 79.
Sea, as a purifier, 86.
Sea, beauties of, 100.
Sea, currents and causes, 86.
Sea, darkness of depths, 107.
Sea, extent of, 79, 81, 83.
Sea, forests in, 95.
Sea, if reduced in size, 83.
Sea, life struggles in, 103.

Sea, living lamps of, 106.
Sea, poem on the, 94.
Sea, Seascape, 93.
Sea Shores, the ancient, 48, 49.
Sea, source of all water, 83.
Sea, storms on the, 80.
Sea vegetation, colours of, 100.
Sea water, in a single drop of, 120–124.
Sea water, minerals in, 84.
Sea water, pressure of, 102.
Sea, waves of and soil, 46.
Sea, zones of life in, 96.
Secrets, revealing our, 159.
Sedgwick, Catherine M., 230.
Seeing with the sense of feeling, 240.
Self luminous bodies in sea, 107.
Sensing dangers, 241.
Sequoia, gigantea, 190.
Servitude to the body, 177.
Shakespeare on music in nature, 246.
Shifting nature of sand, 65.
Sigel, distance to, 15.
Silent deep, the, 115.
Silica, and sea shells, 48.
Silica and soil, 52.
Silicon, abundance of, 52.
Silicon, and quartz, 48, 52.
Sins, blotted out, 160.
Six-rayed snowflakes, 133, 134.
Sleep, a good long, 238.
Small things and the universe, 67.
Snow and climate, 130.
Snow, a protector from cold, 139.
Snow, a type of purity, 142.
Snow, dangers in, 135.
Snowflakes, construction of, 132–134.
Snow, God's goodness seen in, 139.
Snow, hidden power in, 135.
Snow, higher lessons from, 143.
Snow, on mountains, 136, 140.
Snow, poor conductor of heat, 139.
Snow, silent work of, 136.
Snow stars, why so formed, 131, 133.
Snow, treasures in the, 131.
Snow, why white, 140–141.
Soil and sand, 43, 48, 52.
Soil of the earth, how made, 43, 140.
Song of colours, 154.
Song of dying leaves, 155.
Sound transformed into ether waves, 157.
Sound turned to silence, 160.
Spiral nebulæ, numbers of, 26, 27.
Spirit, control of the, 177.
Spirits in a dungeon, 178.
Spiritual grafting, 211–212.
Spiritual life and longevity, 172.
Spores of fungi, 183.
Spores of lichens, 168.
Stanton, Dr. Horace S., on telepathy, 260.
Stars, the fixed, 24.
Starved leaves, 154.
Steel, electric orbs of, 37.
Steel, the atoms of, 37.
Stephen's face shining, 108.
Stinging of jelly fish, 116–117.
Stinging power of sin, 118.
Stones, as witnesses, 148.
Stones, cry out, talk, 147–148.
Stones, geological story of, 153.
Stones, messages of, and how, 152–153.
Stones speak, to whom, 150.
Stoney, Dr. Johnstone, 33.
Sulphuric acid, and soil, 45.
Sun as centre, and symbol, 20.
Sun, brilliancy of the, 19, 20.
Sun, distance to, 20.
Sun, life and energy from, 19.
Sun, pull of on the earth, 17, 18.
Sun, the size of, 19.
Sunlight, abuse of, 20.
Sunlight, need of, 189.
Sunlight, stored up, 19.

Telegraphone, 156.
Telepathy, 255–265.

Telepathy, a frequent occurrence, 257.
Telepathy, Bible examples of, 260.
Telepathy, dangers of, 264.
Telepathy, hints of the future, 263.
Telepathy, how explained, 262.
Telepathy, illustrations of, 261, 263.
Telepathy, is it desirable? 264.
Telepathy, is not occultism, 257.
Telepathy, mystery of, 254.
Thankfulness, cultivating of, 18.
Thoughts registered, 157, 158.
"Through Science to God," quoted, 33, 34, 71, 89, 156, 258, 263.
Tides, cause and value of, 92.
"Time speeds away, away," 50.
Toadstools, 181.
Tongues in trees, 148.
Transformations by grafting, 207.
Transient hopes like sand, 68.
Tree, a Christian like a, 185.
Trees, all good ones are grafted, 207.
Trees and fungi, a contrast, 184.
Trees, hallelujah chorus of, 153.
Trees of the ocean, 95.
Tuttle, Elizabeth, history of, 229.
Tyler, Daniel, 229.

Universe, man's conceptions of, 13.
Universe, our, 26.
Universe, the sensitivity of the, 158.
Universe, what built of, 39.
Universes, the two, 72.
Uranus, distance to and day of, 22.

Vampires, 238, 239.
Vegetable and animal differences and similarities of, 215.
Vegetable meat, 182.
Venus, distance, size and day of, 21, 22.
Vibrations of all things, 149.
Vibrations, seeing those in nature, 149.
Vicarious sacrifice of corpuscles, 219.
Vicarious sacrifice of lichens, 170.
"Vis vitæ Dei," 40.
Vital force, 170.

Waite, Morrison R., 230.
Water, action of on rocks, 43, 44.
Water, a molecule of, 32.
Water and sand, 62.
Water, composition of a drop, 120–125.
Water, the filtering of, 53.
Water, on the earth's surface, 80.
Water, the per cent. of in animals, 81.
Water, temperature of sea, 87.
Waugh, Edwin, 94.
Whitney, Dr. Willis R., 33.
Whitney, Henrietta F., 230.
Whittier, on sea beauties, 101.
Wilson, Andrew, on fungi, 199.
Winds, and revolution of the earth, 130.
Winds, diagram of, 130.
Woolsey, T. D., 229.
Work, the necessity of, 202.

Yielding natures, 60–61.
Young lives, grafting of, 212, 213.

Zones, in the sea, 96.

The Evangelical
School of Theology
248

DATE DUE

UNITED THEOLOGICAL SEMINARY

United Theological Seminary Library
MAIN BL240.T9631 1930
Tyndall, Char Nature and religion :
3 0645 0007 4680 6